Ministry of Transportation
Ontario

MI-128

AN EVALUATION OF BITUMINOUS TEST SECTIONS - VOLUME 2

-Surface treatments

-Spray patching

-Latex modified OFC

-Bituminous friction courses

-Bituminous stabilized base

-Lime as an anti-stripping agent

-Reflux recycling agent

-Stryrelf polymer modified emulsion

-Fog seal

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

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ENGINEERING MATERIALS OFFICE

BITUMINOUS SECTION

DECEMBER 1988

ISBN-0-7729-5095-4

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Abstract

The Bituminous Section of the Engineering Materials Office has initiated a large number of experimental sections to study the performance of new materials, equipment or construction methods. Frequently, the assessment of these trials has not been followed up and their long term performance never established. A program to rectify this situation and to carry out the assessments was put into effect during 1988 and this report is the second of a series which describes the precise location of the trials, assesses the performance of the experimental sections to date and makes recommendations for future work, where applicable.

1. Introduction

Over the past 15 years or so the Ontario Ministry of Transportation has constructed a large number of experimental sections on the Ontario highway system. These trials were intended to study the effect of changing some aspect of the material's make up or of the construction procedure and, generally, to compare their performance against a control section of standard material laid in a conventional manner.

Many of these trials were constructed at the request of private organizations who had made some development that they believed would be beneficial to the pavement performance and which they could market once proven. This could take the form of a proprietary material or additive or a development to the paving or compaction equipment.

Other trials were instigated within the Ministry, either at the District or Regional level or by the Bituminous Section of the Engineering Materials Office, and typically involved the use of an alternative design of mix or source of aggregate of a non-proprietary nature.

In many cases, follow-up work on the trial sections has not been carried out and the long term performance of the trials never determined. The purpose of this report is therefore three-fold:

1. To identify the trial location.

2. Assess the performance to date.

3. To make recommendations for further work where required or to discontinue the trial if appropriate.

The monitoring of many of the trials has been concluded and a summary of the findings is presented in this report for completeness. It is still possible to obtain some useful data from the other trials. A summary of the findings up to the summer of 1988 is given together with some recommendations for future work.

2. Test Site Location

A considerable amount of time was spent in determining the precise location of the test sites. In Volume 1 of this series of reports, a method for establishing test sites was suggested, to enable personnel who wish to inspect the site in the future to easily locate the sections in the field.

This is an important aspect of this type of work as the trials are necessarily long term in nature and take several years, in most cases, for a complete evaluation to be made.

The selection of the test sites can be summarized as follows:

2.1. The choice of test site can influence to a large degree the success, or otherwise, of the trial. The trial site should be long enough to allow the test and control sections to be laid in the same lane. It should be straight and level and devoid of any features that would cause additional loadings to be imposed on the materials in a non-uniform manner.

2.2. An accurate sketch map should be prepared at the time of construction to precisely locate the trial with respect to surrounding landmarks, not just station numbers. This will also enable the LHRS reference system to be used in this application.

2.3. Test sections are normally too long for accurate assessments to be made of the material's performance and it is therefore recommended that monitoring sections be established within each test section. These should be approximately 100 m long and typical of the remainder of the test site.

2.4. Ideally, signs should be erected adjacent to the monitoring sections at the fence line to reinforce the information given on the sketch maps.

2.5. An initial set of data should be taken immediately following construction. The type of measurements will depend on the parameters being studied.

3. Assessments of trial sections

Many of the trials were reported formally in either the EM series or MI series of reports issued by the Engineering Materials Office. The assessment of these trials is referenced to their report number. Other sections were never reported formally, and these are referenced by their subject content to the main filing system located in the Downsview office of the Bituminous Section.

Transverse deformation measurements were taken at a number of test sites as a first stage in establishing a material's resistance to permanent deformation. It is intended that measurements should be made over a number of years making it imperative that measurement procedures are identical on each occasion. A suggested test method was developed and this is presented as Appendix 1 to report MI 124.

3.1. Report number MI 29

Report name Surface treatment with 10-13 mm aggregate (Interim report #1 - Construction and Design data).

Date April 1981

Author R C Aquin

Summary

This report discusses the surface treatment of Highway #121 at Tory Hill using 10 - 13 mm chippings instead of standard 6.7 - 9.5 mm Class 1 aggregate. The objectives of the trials were:

a) To extend service life of surface treatments by reducing premature failure.

b) To provide durable surfacing for traffic volumes in excess of 1000 AADT as Class 1 surface treatments tend to flush with the use of the smaller size of aggregate.

c) To give cost savings by:
   i) extending service life from 5 to (say) 8 years.
   ii) reducing the failure rate of Class 1 surfacings.
   iii) extending the use of surface treatment to roads carrying in excess of 1000 AADT. At the time of this trial, the cost of asphalt cement was increasingly rapidly and ways of reducing the use of hot mix were being investigated.

The trial was constructed to the east of Tory Hill on Highway #121, from Highway #503 to Highway #648 in the summer of 1980. An inspection was made after 1 winter. Dynapac had developed a rubber coated steel drum vibratory roller for surface treatment and this was used for the first time in Ontario on this project. The use of this roller was the only departure from standard construction methods. No control materials were laid at the time of the trial.

Conclusions

1. 10-13 mm aggregate can be produced without difficulty.

2. Standard surface treatment equipment and construction methods were satisfactory.

3. Convoying traffic was necessary and effective.

4. Standard surface treatment design proved inadequate and did not provide sufficient aggregate or binder.

5. The method fits into current Ministry policy of preserving existing Highways through maintenance.

Recommendations of Report MI 29

1. The use of other emulsion grades should be investigated.

2. 10 - 13 mm aggregate should be used in phase 2 of this project (see MI 51).

3. A sand seal may be necessary to improve chip retention.

4. All surface treatments of this type require traffic control to allow time for the emulsion to cure and to prevent broken windshields.

Site Inspection

The site was inspected on 16th August 1988 when the surfacing was seen to be in excellent condition for an 8 year old surface treatment. The binder level in the wheel tracks was very high, generally between 90 and 95 per cent of the thickness of the aggregate. Away from the wheel tracks the binder level was between 60 and 70 per cent of the thickness of the aggregate. The aggregate retention was excellent. At the time of construction it was believed that insufficient binder had been sprayed onto the road but the present condition of the surfacing would suggest that the quantity was about right, or even too high. A design must provide sufficient binder to hold the aggregate in place in the early life of the treatment without causing undue flushing after several years of service.

Some plow chatter was observed at the centre of each lane which had resulted in the loss of some aggregate. The original pavement was reported to have had some slight wheel track rutting and this chatter is probably indicative of the original pavement cross section.

Four large hot mix patches, the largest of which was approximately 0.8 km long, had been laid within the trial section in 1986 to address settlement problems which had become evident on this section of highway. The worst areas had been treated. The quality of the ride is poor in several other areas along the trial and these will no doubt require attention in the near future. The surface treatment was, apparently, in very similar condition in these patched areas to the remainder of the site prior to resurfacing and its performance had no bearing on the decision to resurface. There were some minor patches around badly cracked sections, particularly at the eastern end of the site. However, the quality of the ride over the cracks was still acceptable, despite the fact that the cracks were unsightly. The traffic volume for this section of highway has remained approximately constant, dropping from 1250 AADT in 1979 to 1100 AADT in 1987.

Conclusions

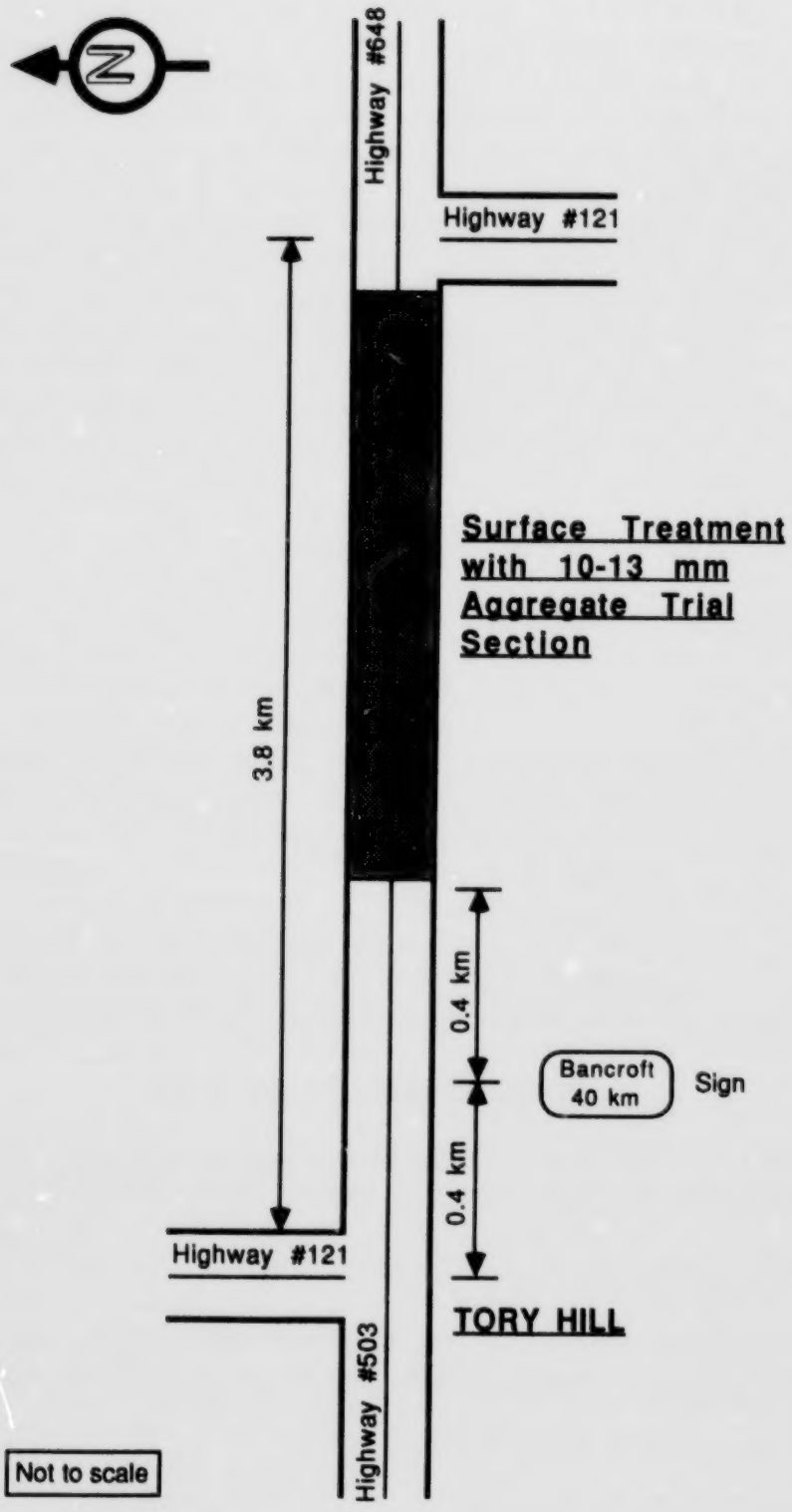
The objectives of this trial have been achieved. The surface treatment has survived on a highway carrying in excess of 1000 AADT and, apart from the major hot mix patches which are not related to the surface treatment trial, the maintenance work appears to be minimal. The binder level is now virtually flush with the top of the aggregate indicating that some refinement of the design procedure with respect to binder viscosity and application rates is necessary. The use of Polymer modified binders has shown some promise in a similar trial carried out on Highway #2 at Prescott (see MI 84). It would have been useful to have monitored the reduction in surface texture depth with time to evaluate how quickly the surface texture was lost. This construction method should be considered for further evaluation by using it in a more major application.

Proposals for future work

1. Continue visual monitoring of the site to evaluate how long the treatment will last before remedial measures need to be taken.

2. Friction testing is being carried out.

3. A detailed analysis of the long term cost benefit should be carried out. This is outside the scope of this summary.



Surface treatment with 10-13 mm aggregate, Highway #121 east of Tory Hill

3.2. Report number MI 88

Report name An evaluation of a high production integral spray patcher.

Date December 1985

Authors R M Rollings
P Korgemagi
D F Lynch

Summary

The Dynapac Pavement Patcher HR21 is a highly mobile, computer controlled, independent patching unit capable of spraying emulsion, spreading aggregate and compacting the patched area all in one pass of the machine. During 1985 five sites were treated with the HR21. The sites were representative of a range of pavement types and defects. It was felt that the HR21 could:

1. Reduce the labour requirements (and hence the cost) of manually patching roads. Selective spray patching with a conventional surface treatment train is cumbersome and inefficient.

2. Improve the riding quality of the road.

3. Provide a viable repair alternative.

The test sites were in Port Hope, Bancroft and Huntsville Districts.

Conclusions from report MI 88

1. The pavement patcher is a viable tool with decreased costs and increased productivity over hand spray patching.

2. Construction posed no serious problems and initial performance of the patches was good.

3. Average cost of patching was \$1.43 per m^2 at a production rate of 850 m^2/h.

4. Cold wet weather during construction had a detrimental effect on stone retention.

Site Inspections

Highway #28

Highway #28 was inspected in April 1986 and was seen to be exhibiting minimal plow damage or aggregate loss; some reflection cracking but most of the patches were still in good condition and the quality of the ride was good.

The pavement had been treated because the edge was breaking up and alligator cracking was prominent. In August 1988 the cracking and break up was again apparent and the road was now generally in bad shape. At the time of the inspection it was being surveyed ready for reconstruction. This will most likely take place in 1990 when an in-place pulverizing method will probably be used. It was very hard to identify where the patcher had been used as the patches had blended into the original surfacing. The binder level was now between 80 and 90 per cent up the thickness of the stone whereas it had been at the 50 per cent level soon after construction. Plows had removed a small amount of aggregate from the leading edge of some of the patches but the damage was very slight.

Highway #46

The Highway #46 site was inspected in April 1986 and it was noted that there was negligible plow damage; virtually no aggregate loss; the cracks had reflected through the patched areas; and the ride was acceptable.

The site was inspected again in June 1988 and was seen to be in generally good condition. The cracks had reflected through the patching and had been subsequently sealed, although it is likely that the less severe cracks have been permanently sealed by the spray patching. The stone retention is excellent with the binder level between 70 and 90 per cent up the stone. The level is lower away from the wheel paths. The patches have blended well into the original pavement giving an acceptable appearance and ride, and only minimal damage has been done by the snow plows. No signs of either flushing or ravelling were noticeable.

Highway #60

The Highway #60 site was inspected in April 1986 when it was noted that plow damage was restricted to the centre line; there was little aggregate

loss; a large number of cracks had reflected through the patches but some were still sealed; and that the pavement was giving an acceptable ride.

The site was inspected again in June 1988. The plows had removed aggregate from the edge of the pavement and at the centre of the lane - particularly at the start of each patch. Otherwise aggregate retention was good with a binder level between 60 and 70 per cent up the stone. Transverse and longitudinal cracks had reflected through the patches and there was some ravelling along the cracks.

Approximately half way through the test section the surfacing exhibited considerable aggregate loss as reported in MI 88. This was caused by cold, wet weather at the time of laying and has resulted in aggregate loss, particularly in the wheel paths, a streaky appearance to the distribution of the binder and considerably more reflection cracking with ravelling of both the surface treatment and hot mix aggregates all along the cracks. MI 88 also reported areas of segregation as one of the pavement defects prior to surface treatment but no such areas were seen and it is therefore concluded that the treatment has successfully sealed the areas concerned.

Highway #117

Highway #117 was inspected in April 1986 when it was noted that the trial had suffered very little plow damage; there was no aggregate loss; the large cracks had reflected through the patches while the smaller ones were still sealed; and the quality of the ride was good.

In June 1988 the site was revisited. The plows had removed aggregate from the beginning of each patch at the centre of the lane. Otherwise aggregate retention was very good with a binder level between 50 and 60 per cent of the stone height. Longitudinal, transverse and alligator cracking have all reappeared with local ravelling of the surface treatment aggregate along the crack edges.

The patches have made no long term improvement to the structure of the pavement. Near the centre of the trial section the binder application is noticeably streaked and aggregate retention worse. The cracks appear more open, particularly at the edge of the pavement and along the right hand wheel path.

Highway #520

Highway #520 was inspected in April 1986 when it was noted that there was negligible plow damage or aggregate loss; the patched areas looked very good with very little substantial crack reflection; and the quality of the ride was excellent.

The site was revisited in June 1988. At the eastern end of the site the binder had risen almost to the top of the stone, particularly in the wheel tracks. Aggregate retention was very good. Cracking had reflected through the surface treated pavement, noticeably at the shoulders and at the centre line. The traffic is presumably partially healing the cracks in the wheel paths.

Moving westerly, the quality of the ride had deteriorated. The original, very thin, surface treated pavement was suffering extensive distress with multiple cracking and some minor potholing. The use of the spray patcher had not improved the pavement's performance in this respect with as much distress seen in the treated as in the untreated areas. However, the original pavement was also reported to have been suffering from edge break-up which is no longer apparent and seems to have been sealed by the spray patching.

Recommendations

1. The use of the Dynapac Integral spray patcher should be restricted to those locations where it is able to correct certain problems in a pavement. It has been conclusively proven that the spray patcher does nothing in the long term to seal major transverse and longitudinal cracks and should not be considered when trying repair them.

2. The spray patcher does appear to have been able to seal areas of segregation, some areas of alligator cracking and, on Highway #520, has prevented edge break up from worsening. The use of the spray patcher could be considered where these faults appear. On Highway #28 the spray patcher appears to have extended the serviceable life of the pavement by 3 or 4 years and so delayed the requirement for major reconstruction. With the restricted budgets of the Maintenance staff, the unit can be used to buy time on low volume highways. Highway #28 had an AADT of 700 in 1983 and 750 in 1987.

3. The spray patcher may have an application in reducing, at least temporarily, the effects of pavement rutting and flushing and trials to assess this potential should be considered. The selection of chip size and binder spread rate will have to be carefully selected in both these applications but the treatment may postpone the need for major remedial work.

4. The treatment can be considered where it is necessary to restore surface texture and close up the surfacing in an area where ravelling or segregation is a problem.

5. When using the HR21 patcher consideration should be given to utilizing a rubber tired roller if the cross section of the existing pavement is less than acceptable. The steel rolls on the patcher permit the machine to bridge low areas (such as ruts) leading to a lack of compaction and possible premature aggregate loss.

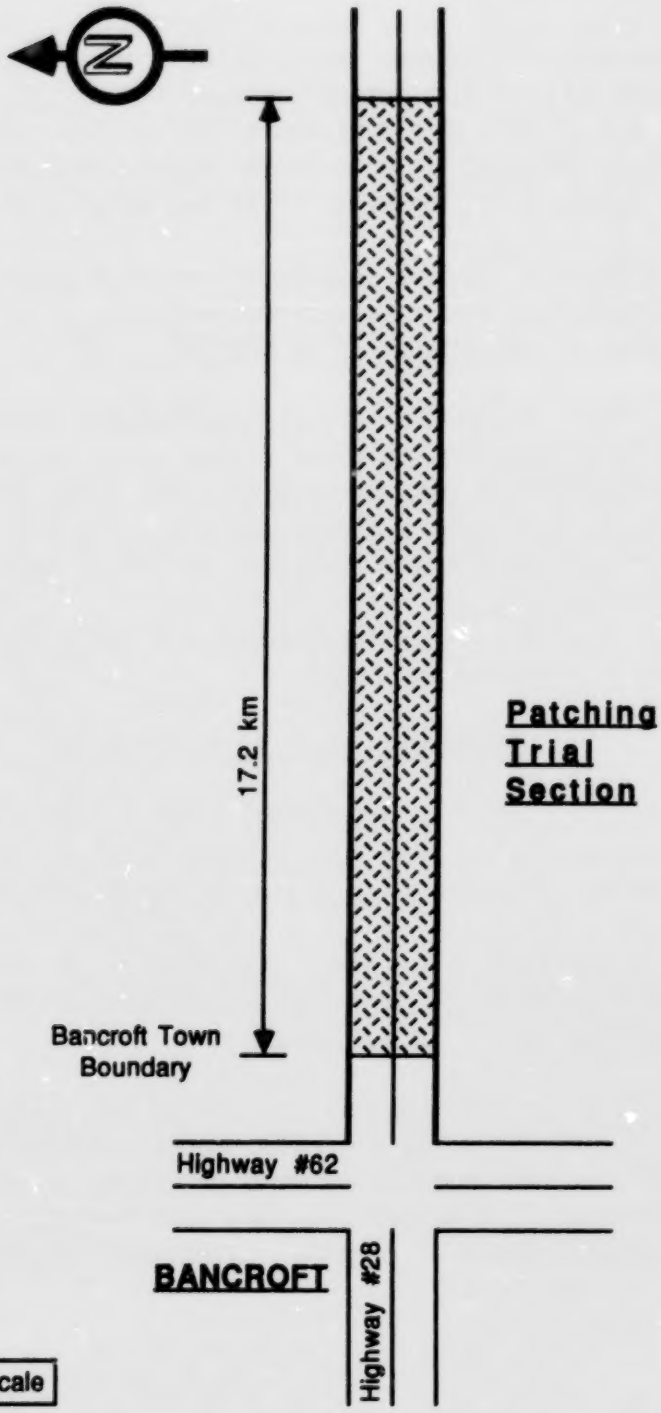
6. When used in the right application, the HR21 patcher provides a valuable maintenance option.

Proposals for further work

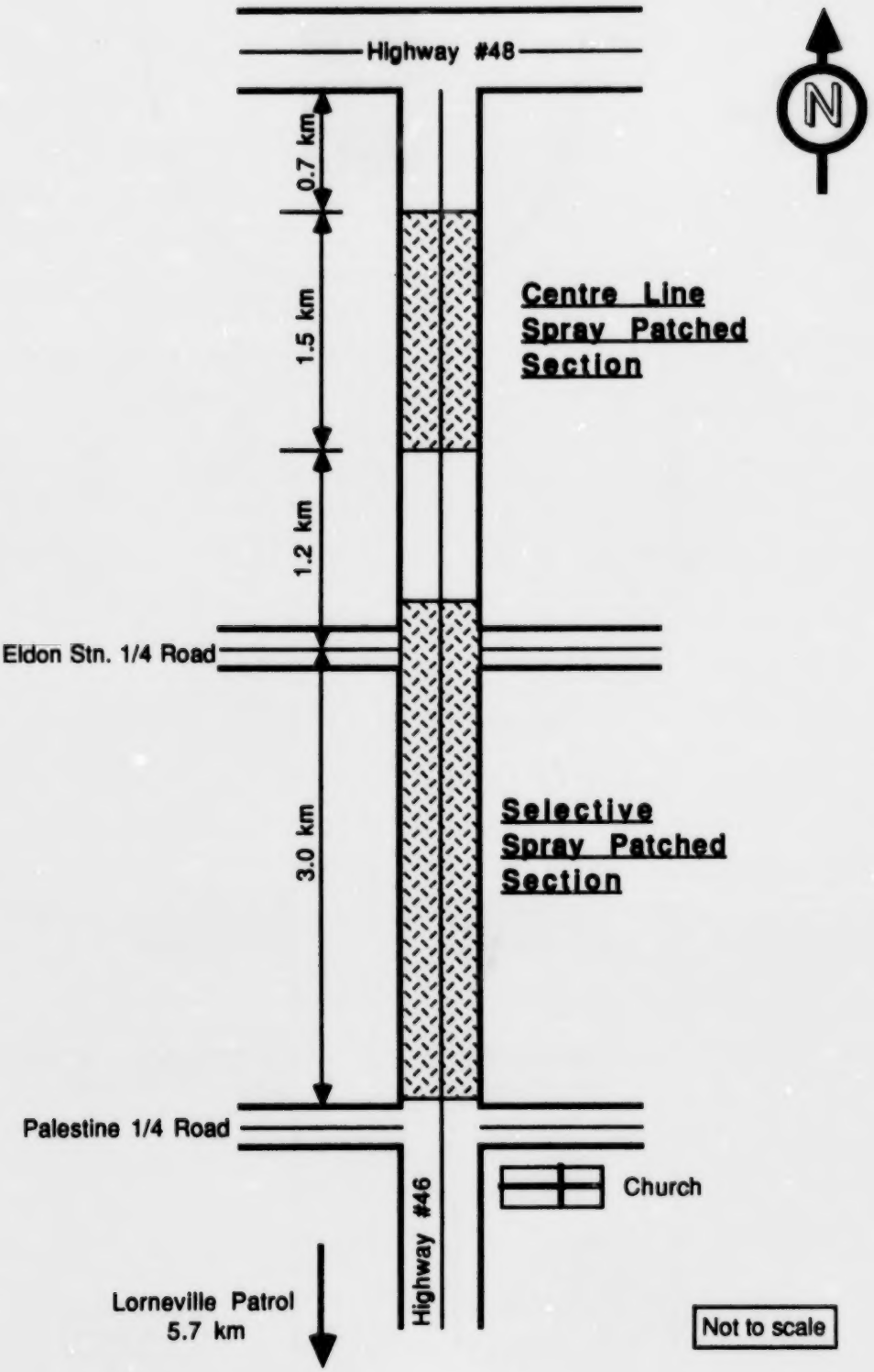
1. As noted in (3) above, the HR21 should be considered in cases where pavement rutting and flushing is a problem and trials should be established to assess its value in such situations.

2. The performance of the HR21 may also be improved by using polymer modified binders and comparative trials against an unmodified control binder would be valuable.

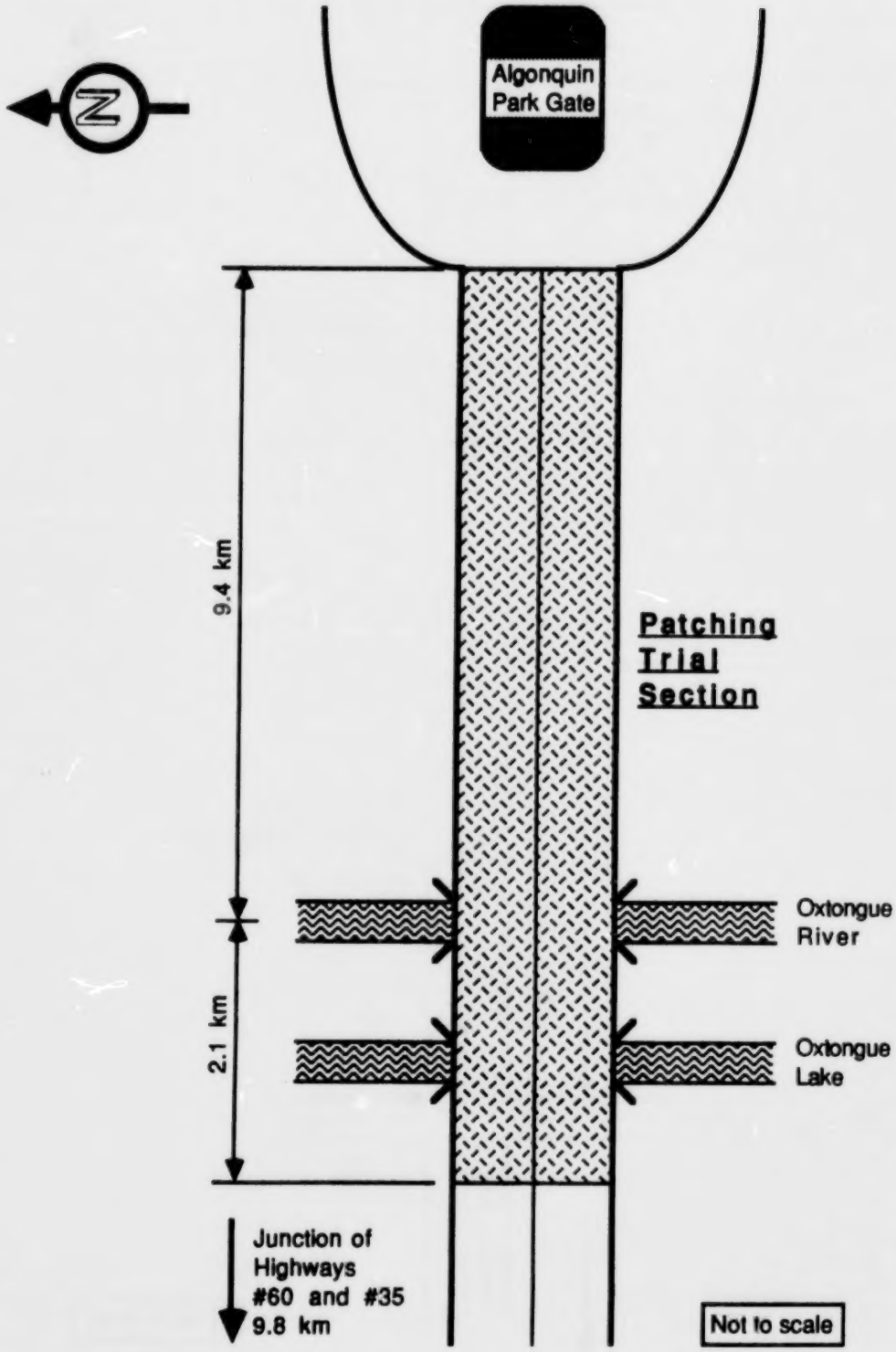
3. No further detailed work is considered necessary on the five sites investigated above, as the HR21 spray patcher has proved its value in certain applications and continues to be used throughout the Province. It is recommended that the sites be visually assessed annually, if possible, to observe the longer term performance.



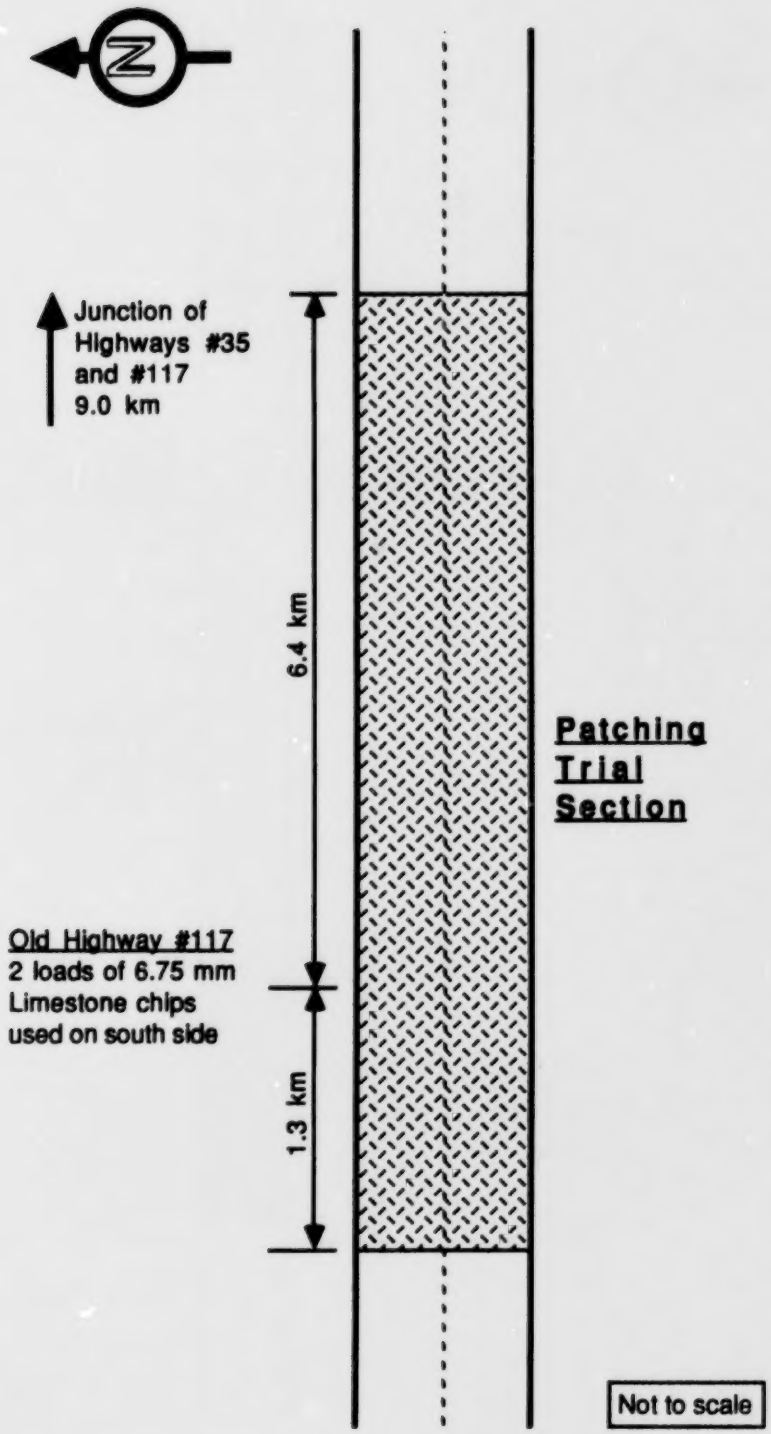
Integral Spray Patcher - Highway #28 east of Bancroft



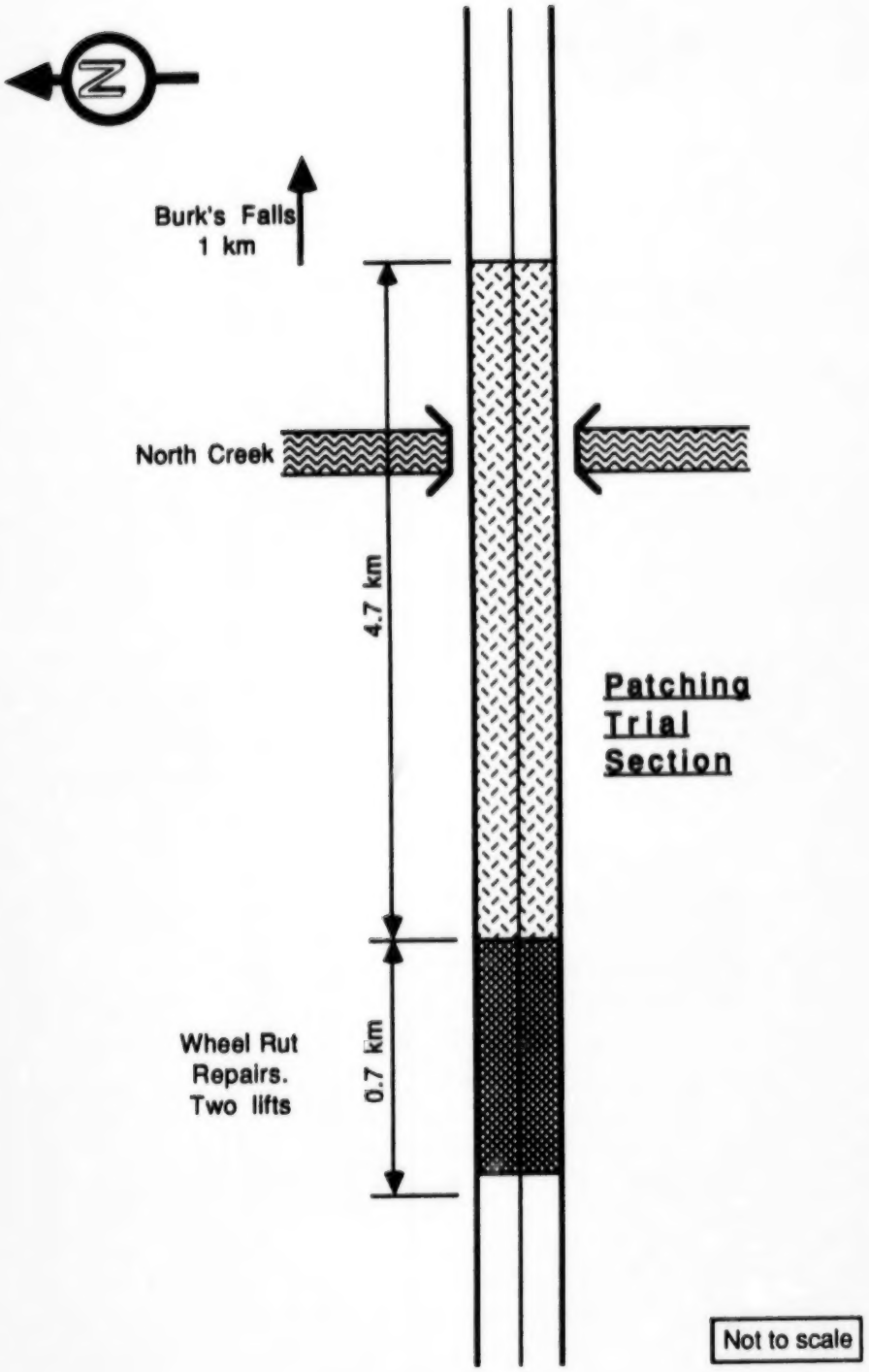
Integral Spray Patcher - Highway #46, north of Argyle



Integral Spray Patcher - Highway #60 west of Algonquin Park



Integral Spray Patcher - Highway #117



Integral Spray Patcher - Highway #520

3.3. Report number MI 94

Report name: Latex modified OFC. Construction report.

Date

Authors: R Rollings
J Dickson
D F Lynch

Summary

In September 1985 a trial section of latex modified open friction course was placed on the westbound core lanes of Highway #401, between Dufferin Street and Keele Street, as part of Contract 85-58. The section is approximately 225 m long and covers the 2 passing lanes and left shoulder. The modifier was Polysar Latex 275, claimed to enhance the performance of hot mix by:

1. Increasing high temperature stability.
2. Improving low temperature flexibility.
3. Retarding the ageing process.
4. Greatly improving adhesion.
5. Eliminating binder run-off in OFC mixtures.

The control OFC mix had 65 per cent retained 4.75 mm and an 85/100 pen. binder content of 5.2 per cent. The modified OFC was identical except for 3 per cent by weight of latex solids in the asphalt cement.

Conclusions of Report MI 94

1. The method of latex addition would need refining for production mixes.
2. A laboratory testing programme indicated that the addition of latex had improved the cold weather performance without compromising 'summer' performance. Indeed, with increased softening points and viscosity, hot weather performance may be

enhanced also.

3. Some of the cold temperature benefits are lost due to higher mixing temperature and longer mixing times.

Site Inspection

The site was inspected from the shoulder in June 1988. No difference could be seen between the latex modified material and the remainder of the contract, which is acting as the control. A control section was established in the unmodified material to be used for comparison purposes in future assessments of the trial. This is located to the west of the modified test section in the two left hand lanes so that it is subjected to the same traffic loadings as the experimental section.

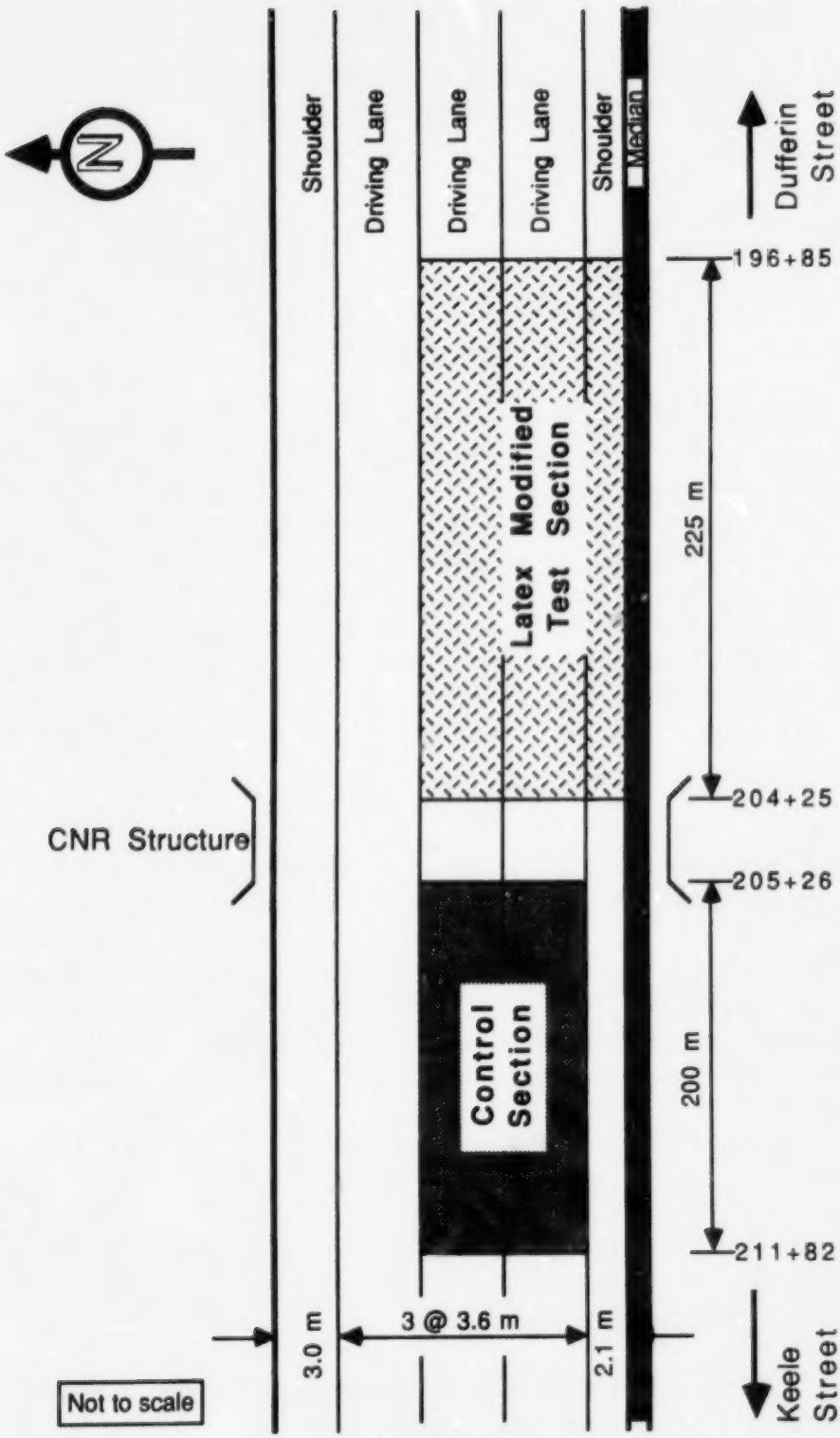
Proposals for further work

The modified materials have now been in place for 3 years and are behaving as well as the control materials with virtually no cracking or aggregate loss on a section of highway carrying very heavy traffic. The Ministry has not been using unmodified OFC mixes long enough for the durability of the standard mix to be established with any confidence and it is in the long term performance that the latex modified material should be superior. The manufacturer claimed that, by improving high and low temperature performance and by retarding the hardening process due to aging, a more durable material will result. The trial should therefore continue to be monitored to assess the manufacturers claims. The following parameters should be evaluated:

1. With the sections of road closed to traffic, carry out a thorough examination of the site including crack mapping and deformation profiles to assess high and low temperature performance of the control and modified mixes. As this section of highway is very busy, this may have to be carried out at night or at the week-end.

2. Carry out permeability measurements to assess whether the mixes are closing up and becoming impermeable with time.

3. Carry out an analysis of recovered binders to observe changes in recovered penetration, softening point and viscosity. The asphalt cement content testing may also confirm whether the latex has eliminated run-off in the OFC mixes although run off was not reported as having been a problem in the construction report.



Latex Modified OFC - Highway #401 westbound core lanes

3.4. File number 139

Subject: Construction and performance of bituminous friction course sections at Lindsay, Ontario.

Date: May 1979

Authors: N Kamel
J T Corkill

Summary

Seventeen test sections were constructed during 1978 on Highway #7 west of Lindsay, including open and dense-graded mixes, as part of Contract 78-35. Coarse aggregates evaluated were Southern Ontario limestone gravel, better quality crushed igneous gravel and a blend of both materials. Fine aggregates included local sand, limestone screenings and screenings from an igneous source, used alone or in blends. The objective of the project was to develop surface course mixes with a good surface texture and longer lasting skid resistance, without resorting to scarce, premium quality aggregates. The Research and Development Division issued a preliminary report on this project under the number AMR 80-002.

Conclusions

1. Initial skid resistance depends on quality (angularity and harshness) of fine aggregate as well as coarse aggregate.

2. The limestone group generally produced lower skid resistance. When limestone coarse aggregate was used in conjunction with igneous fine aggregate a significantly higher friction properties were obtained than a mix using entirely limestone aggregates.

3. The igneous group, and mixes with a blend of igneous and limestone coarse aggregate, provided the highest skid resistance.

4. Dense friction course with high coarse aggregate content and open friction course made from similar aggregate blends gave similar skid resistance values.

5. Skid resistance levels of limestone mixes can be improved by blending with igneous coarse aggregate.

Site Inspection

The site was inspected in March 1988. Unfortunately the inspection took place during a period of very heavy rain but a quick assessment was sufficient to reveal that most of the sections, particularly those at the eastern end of the site, were in very bad shape. Severe ravelling along cracks had been patched but the patches were now showing signs of distress. Large areas had become delaminated. One or two sections were apparently in fair condition but a closer inspection is required.

The site was inspected again in May 1988. Generally the surfacing appeared to have been laid in very thin lifts (as low as about 12 mm in places) and this, coupled with severe brittleness of the asphalt cement and the suggestion of a stripping problem, has led to break-up and delamination of some sections. More work in the laboratory would be needed to confirm the mechanism of failure such as stripping tests and viscosities of the recovered asphalt cements.

Each section was inspected in detail and the following observations were made:

Section	Mix Type	Materials	Observations
1	OFC	Maple Ridge stone and washed Maple Ridge screenings	Very good condition with very few transverse cracks exhibiting slight ravelling. The centre line was cracked.
2	OFC	Beamish (brown) stone and washed Maple Ridge screenings	Poor performance. Ravelling and delamination - possibly aggravated by thin paving of only 10 - 12 mm approximately in places. Cracking was observed in the centre of both lanes.
3	OFC	Blend of Beamish and Maple Ridge stone with washed Maple Ridge screenings	Extensive delamination at centre line, the material taking on a biscuit-like consistency. The west bound lane was ravelled and cracked at the centre of the lane and at the pavement edge. Again

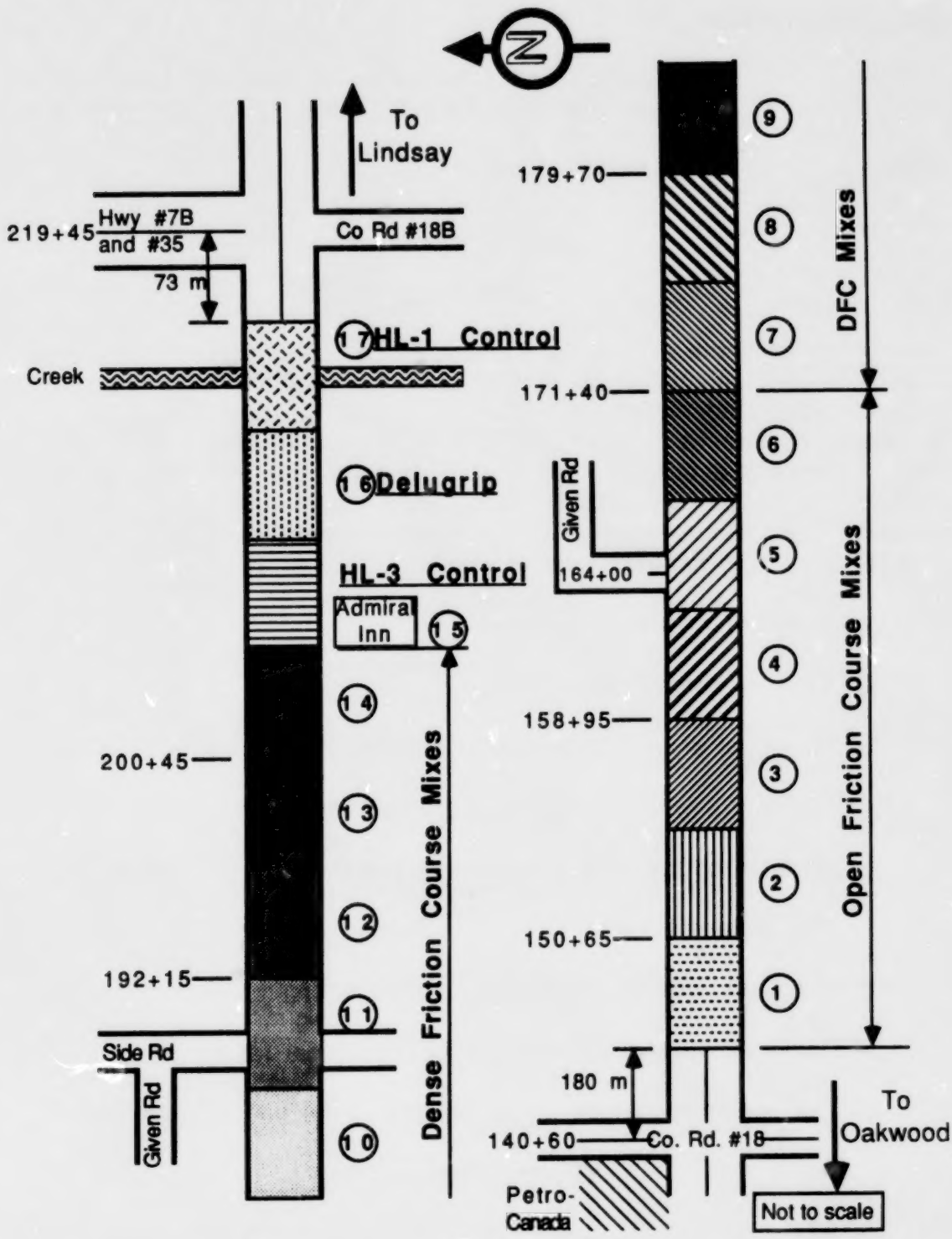
			this was possibly aggravated by thin paving.
4	OFC	Blend of Beamish and Maple Ridge stone with washed Beamish (brown) screenings	Relatively good condition. Short (partial lane) transverse cracking with centre line cracking and delamination.
5	OFC	Beamish stone with washed Beamish (brown) screenings	Coarse aggregate pop-outs throughout the section with areas of extensive ravelling. Cracking at the centre line has been patched and delamination is also occurring. Cracks are beginning to form in the middle of each lane.
6	OFC	Maple Ridge stone with washed Beamish (brown) screenings	Coarse aggregate pop-outs and ravelling are occurring throughout the section with delamination at the pavement edge. Some minor cracking was observed in the east bound lane and a large (4 m x 2 m) area has become delaminated at the western end. The asphalt cement was seen to be very brittle.
7	DFC	Beamish stone with Ormell sand	Poor condition. Non-continuous wavy cracks run parallel to the centre line and delamination has occurred at the centre line and at the pavement edge. No transverse cracks were seen but the pavement has poor shape.
8	DFC	Beamish stone with Ormell sand and unwashed Beamish screenings	The section appeared to be in the early stages of cracking into rectangular blocks. Multiple cracks ran parallel to the centre line and at the centre of each lane. Part-lane transverse cracks were apparent.

9	DFC	Beamish stone with Ormell sand and unwashed Maple Ridge screenings	Longitudinal and transverse cracks straddle half a metre each side of the centre line. Some very fine, part lane, transverse cracks were seen as well as ravelling and cracking in the wheel tracks.
10	DFC	Beamish stone with unwashed Maple Ridge screenings	Few full width cracks but frequent part lane transverse cracks straddling the centre line. Small amount of ravelling in the wheel tracks.
11	DFC	Maple Ridge stone with unwashed Maple Ridge screenings	Part and full lane transverse cracks exhibiting some ravelling. Meandering longitudinal cracks cross centre line from wheel track to wheel track. Minor ravelling in the wheel tracks.
12	DFC	Maple Ridge stone with unwashed Beamish screenings	Ravelling and potholing were seen in the wheel tracks with distress concentrated at intervals suggesting the end of each truck load. Segregation may be a cause. Longitudinal cracking was seen at the centre line.
13	DFC	Blend of Maple Ridge stone and Beamish stone with unwashed Beamish screenings	Ravelling and potholing were observed in the wheel tracks. Stripping was suspecting as uncoated stones were seen in the underside of the surfacing. The eastbound lane appeared to be much better than the westbound lane.
14	DFC	Beamish stone with unwashed Beamish screenings	Cracking and ravelling concentrated in the wheel tracks with some potholing caused by delamination of the surfacing.

15	HL-3	Beamish stone with Ormell sand	This HL-3 control section was in good condition with transverse cracks at 3-5 m centres.
16	Delugrip	Blend of Maple Ridge stone and Beamish stone with unwashed Maple Ridge screenings	'Delugrip' section had extensive transverse and longitudinal cracking creating multiple rectangular blocks. The cracks have ravelled and delamination has occurred, especially in the eastbound lane. The westbound lane has virtually no delamination.
17	HL-1	Traprock stone with Ormell sand	HL-1 control section performing satisfactorily. Transverse and longitudinal cracks were present but they are probably not due to any shortcomings in the performance of the HL-1.

Proposals for further work

This section of highway was resurfaced in August 1988 and a more detailed report on the performance of the materials is being prepared. No further work is therefore required.



Friction Course Sections - Highway #7 at Lindsay

3.5. File number 217

Subject Construction and performance of stabilized base on Highway #620 near Chandos Lake.

Date September/October 1970.

Author

Summary

In order to eliminate the use of expensive and scarce Granular 'A' material in regions with an abundance of fine sand, trial sections were laid on Highway #620 under contract 69-181 to assess the potential of stabilizing fine sands with emulsified and cutback binders. Nine trial sections were laid utilizing two sources of sand and two construction methods - a conventional asphalt paver and a Jersey spreader. The emulsion used was SS-1-H while 2 cutback bitumens were used; RC-800 and RC-250. The benefits claimed were:

1. Economy of using local materials.
2. Ease of construction.
3. Saving of scarce materials by using readily available ones.

Conclusions

1. Because of the cold, wet weather the emulsion did not set-up.
2. The materials were difficult to compact - very tender.
3. The base was trafficked before bond strength was established.
4. Conventional asphalt paver could not handle the mixes.
5. The construction took place too late in the year for success.

Visual Inspection

The site was inspected in August 1988. Because of the age of the trial and the general conclusion that it was not a success, it was proposed to limit the amount of follow up work. The stabilized base had been left

exposed to traffic for a year following construction after which it was paved with an HL-4 surfacing. The pavement has not undergone any extensive repair since that time. The surfacing is still tight with a few coarse aggregate popouts and the ride is fairly good. The stabilized base was visible at the shoulders. At the eastern end of the trial where the emulsion had been used the base appeared under-asphalted, dead and brittle. At the western end of the trial the cut-back bitumens had been used and the mix appeared much richer and more lively. It was difficult to break a piece of the mix in the hand.

An evaluation of the trial was made by visually assessing the number and severity of the cracks in each of the 9 sections. The observations made were as follows:

Section	Binder	Observations
1	Emulsion	Transverse cracks were typically at between 6 and 8 m centres although the spacing did vary from 5 to 15 m. Occasional longitudinal cracks were observed at the centre of each lane and at the centre line. Some of the cracks were associated with a structural failure and the major cracks had dished which is a common feature associated with sand bases.
2	Emulsion	The crack distribution was very similar to that seen in Section 1. One stretch approximately 40 m long was uncracked.
3	Emulsion	This section is only 111 m long but transverse cracking was assessed to be at between 3 and 10 m centres. Longitudinal cracking was minimal.
4	Emulsion	The crack frequency was assessed to be very similar to that observed in Section 3.
5	Emulsion	The transverse crack spacing was assessed to be between 5 and 30 m, with the majority of the spacings being longer rather than shorter.
6	Cut-back	The transverse crack spacing was in the range 5 to 30 m, with one section approximately 80 m long with no cracks.

7	Cut-back	The majority of the transverse cracks were at spacings ranging from 50 to 150 m. There were some short stretches where the spacing was the more typical 5 to 15 m.
8	Cut-back	The crack spacing was assessed to lie in the range 7 to 30 m with one uncracked stretch approximately 80 m long.
9	Cut-back	The majority of the cracks were at spacings ranging from 30 to 50 m with a few at spacings of 7 to 30 m.

Conclusions

The stabilized base treatment caused some concern and difficulty during construction, aggravated to a considerable degree by carrying out this paving very late in the year, during cold and wet weather. The stabilized base had to be opened to traffic while still tender and this resulted in the need to reshape the road prior to paving with hot mix in the following construction season. Since that time the road has been in service for 18 years with very little maintenance work being required. No crack sealing has been carried out and the riding quality has remained good. This section of Highway #620 had an AADT of 400 in 1987.

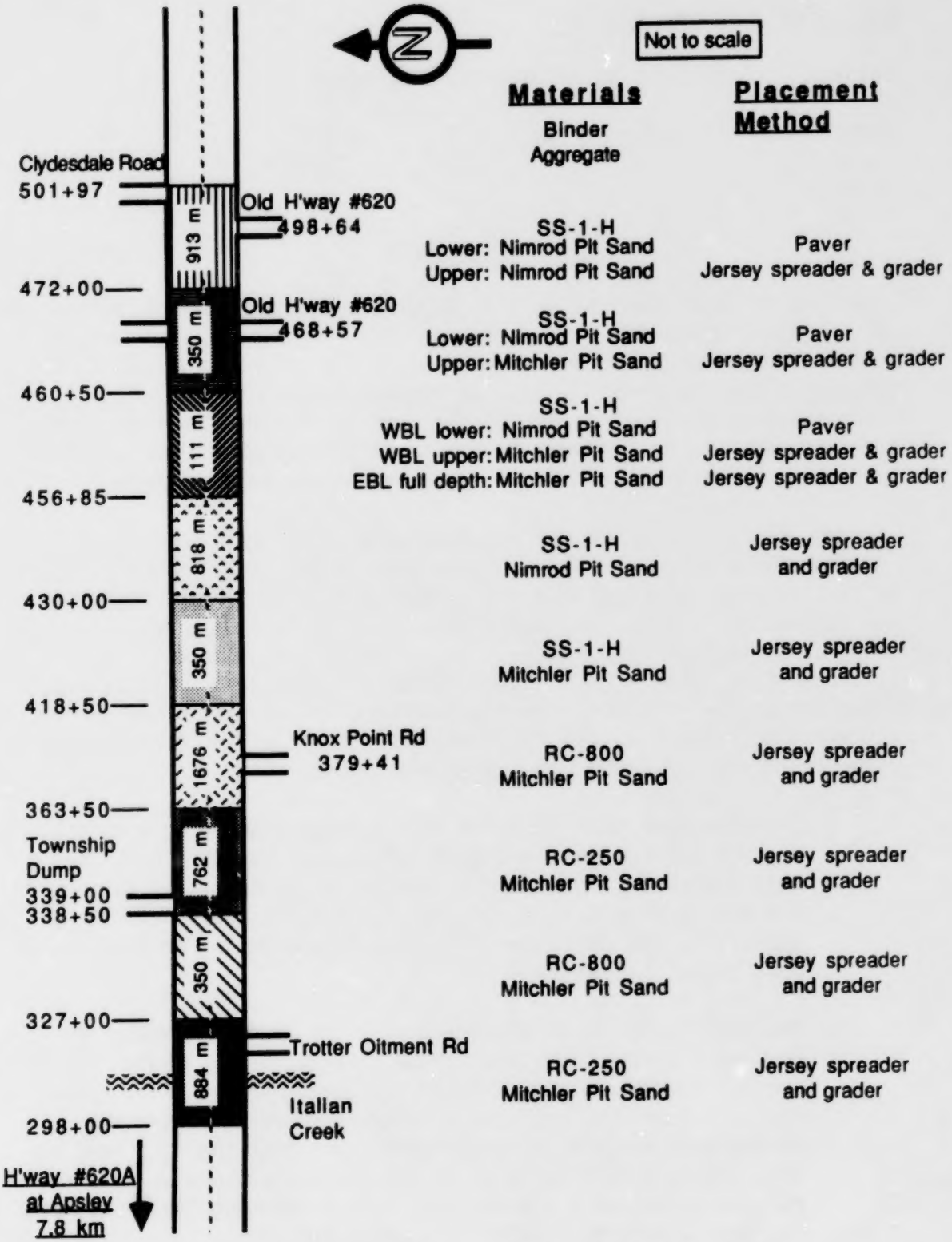
From the visual crack survey carried out it would seem that the materials with cut-back binders are giving improved performance over the emulsion bound materials, based on the frequency of the cracks.

Proposals for future work

1. Crack sealing of the trial site should be carried out to seal the surfacing.

2. An economic re-assessment should be made of this process to determine whether it still has any potential as a cost and material saving procedure.

3. Continue visual observations of the site to establish development of further cracks. This would be of considerable importance if the cracks are to be sealed but otherwise could be done every 2 or 3 years



Stabilised Base - Highway #620, Chandos Lake

3.6. File number 254

Subject Lime as an anti-stripping agent.

Date Laid early July 1988.

Author

Summary

Lime had not been used as an anti-stripping agent in Ontario since the late 1960's. Contract 69-82 involved the paving of Highway 62 from Maple Leaf to Purdy in Bancroft District with HL-4. At the southern end of the site, 2 per cent by weight of total aggregate of hydrated lime was incorporated in the mix. At the northern end of the site, the use of lime was discontinued and replaced by 2 per cent of limestone filler and 1 per cent of Kling anti-stripping agent was added to the asphalt cement.

Contract 87-231 called for the resurfacing of Highway #11 from Englehart River Bridge northerly to Highway #112. 2000 tonnes of 40/60 recycled hot mix were laid with lime added at a rate of 1 per cent of the total aggregate weight. The remainder of the contract had 40/60 recycled hot mix laid as control material using a standard anti-stripping agent known as 'Kling Beta'. Later the contractor changed from this material to CES446 produced by Armak Chemicals. The work was carried out by the Northern Region, District #14 New Liskeard. Some of the observations made at the time of construction were as follows:

1. The lime was delivered to the site in bags which then had to be opened and the lime transferred into a cold feed bin. This was a very unpleasant task and the operatives complained of burning of the skin, eyes and throat caused by the flying lime. A more acceptable method would need to be developed before lime can be used more extensively.

2. The aggregates were first mixed with the lime by passing the cold mixture through a drum mixer. Proportioning of the lime in the mix was achieved by feeding the aggregate onto the gathering conveyor from the first cold bin, followed by lime from the second cold bin and then aggregate again from the third cold bin, thus making a lime sandwich on the gathering conveyor. Hence, the lime could not be blown away before entering the drum mixer and was evenly distributed throughout the mix.

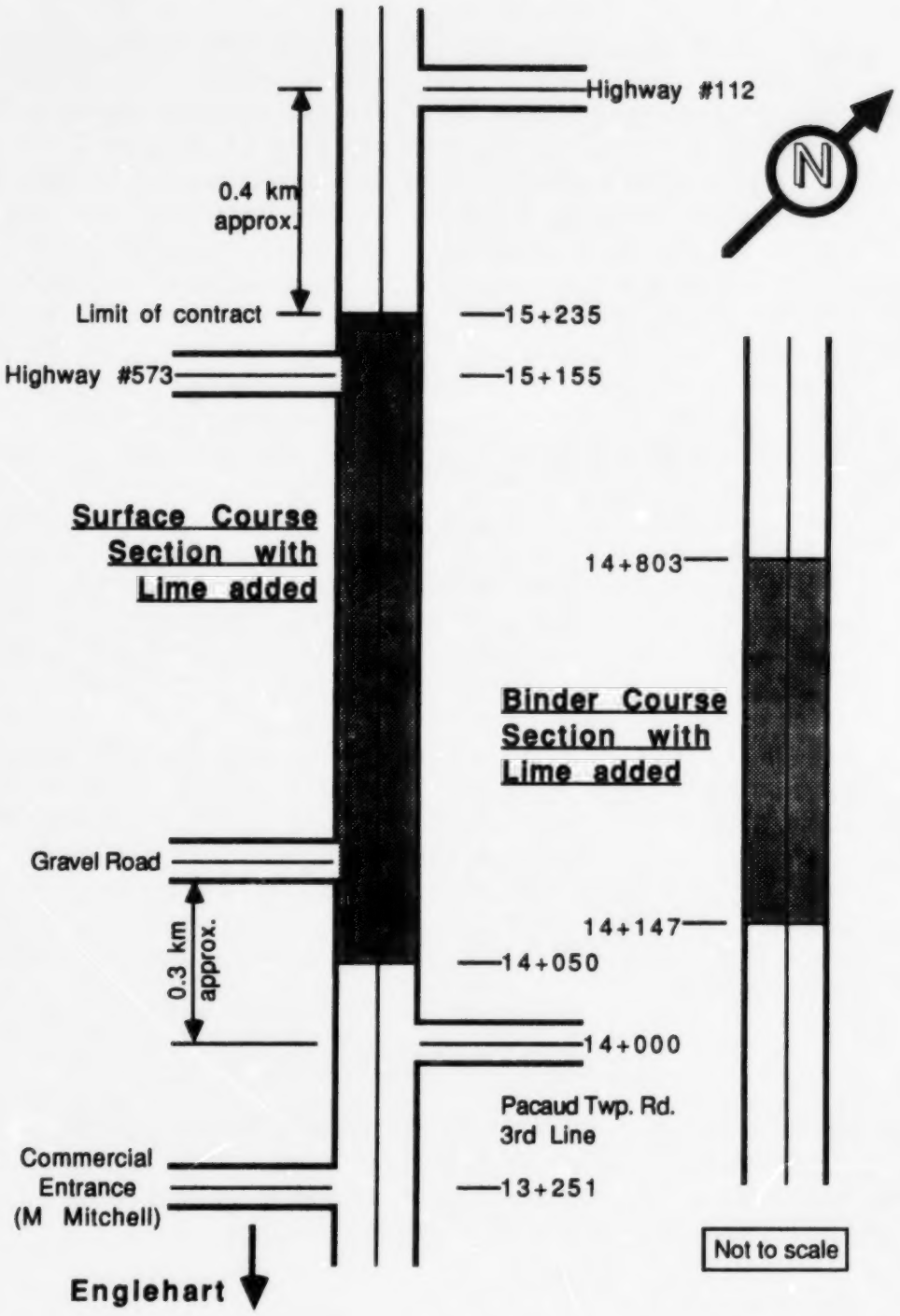
3. The mixture was discharged into the silo from where it was dumped into trucks and hauled to the stockpile. The moisture content of the aggregates was sufficient to retain the lime on the aggregate particles but the stockpile may be sprayed if necessary. It was observed that the coarse aggregate was well coated with lime after mixing. The fine aggregate was also well coated but was very cohesive. After mixing the RAP, some problems were encountered with material sticking in the cone of the silo and a considerable period of time was lost in cleaning it out. The contractor reduced the problem by not keeping too much material in the silo at any one time - emptying it out after every 2 or 3 tonnes. The mixing method was reported to work extremely well and gave a well distributed, uniform mix.

4. The lime treated hot mix produced the following day was reported to look very good although it did appear to be somewhat tender. The weather was extremely hot at 29°C and it was felt that this was the reason for the tenderness. The contractor placed the material in the binder course between stations 14+147 and 14+803 in both lanes of the highway.

5. The lime treated hot mix was also laid in the surface course of both lanes between stations 14+050 and 15+235 where it showed signs of slight flushing. Again this was partly attributed to the hot weather and to the temperature of the mix. The Ministry inspector on the job requested that the mixing temperature be reduced from 290°F to 260°F and this reportedly brought the problem under control. It was not considered likely to create long term difficulties.

Proposals for further work

This project will be the subject of an Engineering Materials Office report following a laboratory evaluation of the materials. The site itself will also be monitored and further samples extracted to compare the performance in the field with the laboratory findings.



Lime as an anti-stripping agent - Highway #11, Englehart

3.7. File number 420

Subject: Evaluation of recycled bituminous pavement as recycled bituminous treated base.

Date: 1981

Author: B P Walker Associates Ltd.

Summary

Contract 81-100 called for the reconstruction of Highway #7/12 from Brooklin northern limits to Highway #7A at Manchester. Two trial sections were constructed to evaluate the potential of using the recycled pavement as a bituminous treated base (BTB), that is, with no asphalt cement added to the recycled hot mix which is reheated, mixed with 30 per cent virgin aggregate and laid in the conventional manner. The use of BTB as a replacement for one of the binder courses was an additional aspect of the investigation with the potential of large savings in asphalt cement that the material would offer over conventional recycled mixes. The existing pavement was an extensively patched, 25 year old bituminous road which was removed by milling. Under this was the original, 50 year old concrete pavement.

The non-experimental part of the contract consisted of:

-2 lifts 1.5 inches thick of recycled hot mix binder course with added asphalt.
-1 lift 3 inches thick of recycled bituminous base with no added asphalt.

Section 1
The first trial section was from Station 234+36 to 244+36:
-2 lifts 1.5 inches thick of recycled hot mix binder } Both with added
-1 lift 3 inches thick of recycled hot mix to replace BTB } asphalt

Section 2
The second test section was from Station 254+36 to 264+36:
-2 lifts 1.5 inches thick of recycled bituminous base } With no added
-1 lift 3 inches thick of recycled bituminous base } asphalt

Conclusions

1. Both BTB and RHM had good placement characteristics.

2. BTB had very high stability and may be brittle. It should be considered as a rigid pavement.

3. BTB had high voids which may leave it open to frost damage and stripping of the binder from the aggregate, although stripping was not considered to be a problem on this contract.

4. BTB is recommended as a replacement for the first binder course where two lifts of binder are called for.

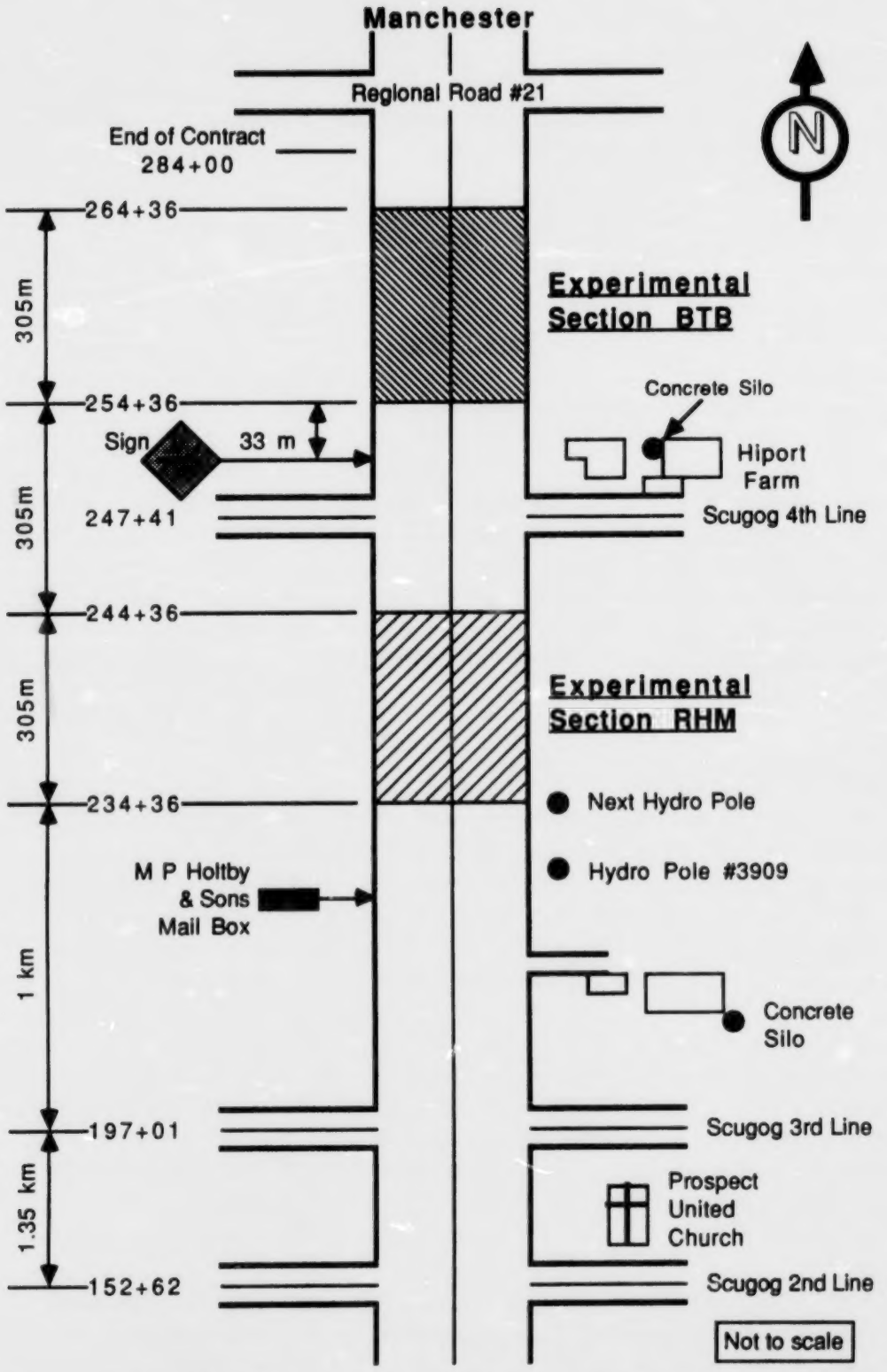
Visual Inspection

The site was inspected in June 1988. The RHM experimental section, Section 1, had only 3 transverse cracks of low severity, only one of which was across the full width of the pavement. The BTB experimental section, Section 2, was seen to be in good condition with transverse cracking every 5-6 m. This seemed to confirm the laboratory findings that the BTB had high stability values but tended to be brittle. It was also reported to have a high pavement voids content which may be increasing the degree of cracking in the BTB. There was extensive edge cracking, some of which had been sealed, but this may not be of significance to the assessment of the experimental sections. Two 20 m long sections in the wheel tracks of Section 1 exhibited severe bleeding. This may not have any bearing on the evaluation of the experimental materials.

Proposals for further work

1. The monitoring of the test section should continue to study how the cracking develops and if the brittleness of the BTB has a detrimental effect on the long term durability of the pavement.

2. Cores should be taken from the BTB to carry out recovered penetration tests and to determine present Marshall stability and flow values. The cores can also be used to confirm the pavement voids data in the original report and to see whether the high voids has led to any other problems such as stripping.



100% recycled BTB - Highway #7/12, south of Manchester

3.8. File number 578

Subject Reflux Recycling Agent used on Highway #45 between Hastings and Norwood.

Date

Author

Summary

Reflux recycling agent is an emulsion with a residue of approximately 65 per cent after evaporation. Three trial sections were laid in August 1982 on Highway #45 as part of Contract 82-20 which ran from 3.2 miles south of Hastings southern limits northerly to Highway #7 in Norwood, excluding the portion in Hastings, and on Highway #7 from 0.1 miles east of Norwood eastern limits easterly 5.0 miles. A 60:40 recycled mix was used on the non-experimental portion of Highway #45 on this contract. The Reflux was added at a rate of 15 per cent of the asphalt cement content in the old pavement. The trial sections were laid between Hastings and Norwood as follows:

Section 1
100 tons of 70:30 recycled binder course mix was laid between stations 148+00 and 157+50 in the northbound lane. The mix was produced at 140°C and arrived at the paver at 122°C. A significant amount of blue smoke was produced when mixing this material, and it was noted to be slightly more 'sticky' than the regular mix. The southern end of this section is in front of Donaldson's house on the east side of the highway - a light brown house with dark brown roof and a small brown barn.

Section 2
100 tons of 50:50 recycled binder course mix was laid between stations 165+00 and 173+00 in the northbound lane under the same conditions as the previous section. The blue smoke visible with the first mix was not observed with this material. The mix appeared rich immediately after laying but was quite satisfactory after 1 h under traffic.

Section 3
A section of 50:50 recycled surface course material was laid between stations 193+00 and 202+50 in the northbound lane. The 100 tons of material was manufactured in the same way as for the previous 2 sections

and it was noted that the rate of feed of the Reflux was 3.5 gallons per minute with the drum mixer operating at 300 t/h. The north end of this section is approximately 5 km from the traffic lights in the centre of Norwood.

Visual Inspection

The site was inspected in May 1984 and was reported to be in good visual condition. The surfaces of the standard and Reflux mixes appeared the same with a small amount of coarse aggregate pop-out in both mixes. A few edge cracks were apparent in the standard mix but this was believed to be due to the proximity of standing water. A small number of wheel track alligator cracks were visible throughout the contract. The pavement edge was generally tight and the surface texture close.

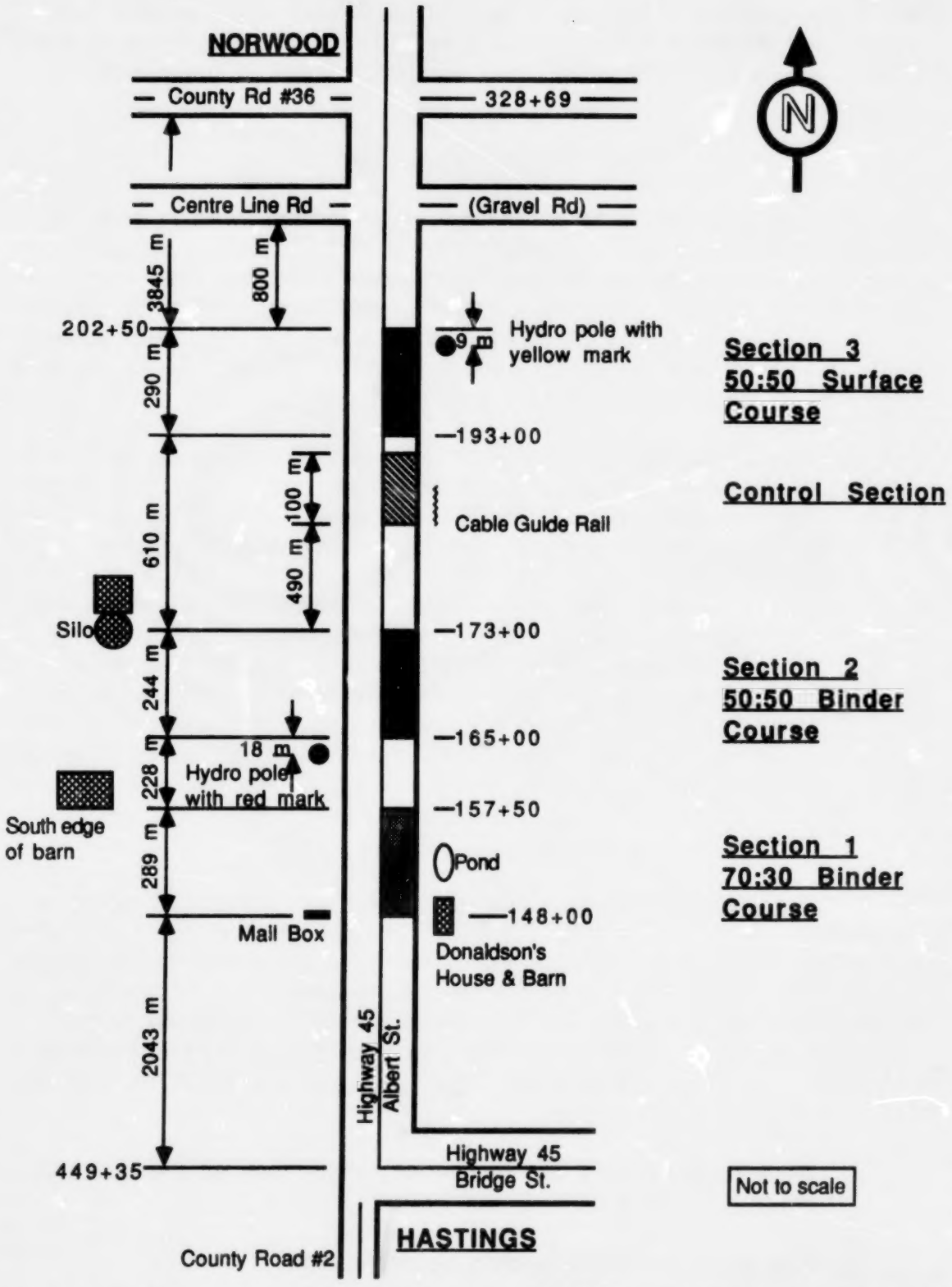
The site was inspected again in July 1988 when crack mapping of monitoring sections within the trials was carried out. A 100 m control section was also crack mapped and this is located between sections 2 and 3. Section 1, the 70:30 binder course section, exhibited extensive longitudinal edge cracking and 3 full width transverse cracks in the 100 m long monitoring section. Section 2, the 50:50 binder course section, had some longitudinal edge cracking at the southern end of the monitoring section and no transverse cracks while Section 3, the 50:50 surface course section, had no longitudinal cracks and 2 part width transverse cracks. The control section had 4 full width and 2 part width transverse cracks but no edge cracking. Most of the cracks had been sealed. Frequent coarse aggregate pop-outs were visible in all the sections.

Proposals for further work

Although Reflux recycling agent has been used at a number of locations since this trial was laid, this was the first application of the material on the Ontario highway system and has hence been in service for the longest period of time. The assessment of the trial sections should therefore be continued so that an assessment of the long term performance of the agent can be made. Any benefits derived from the use of this material should become more apparent with age. The traffic intensity on Highway #45 is only 2150 AADT (1986).

1. Take cores to carry out recovered penetrations on the test and control materials.

2. The crack monitoring should be continued.

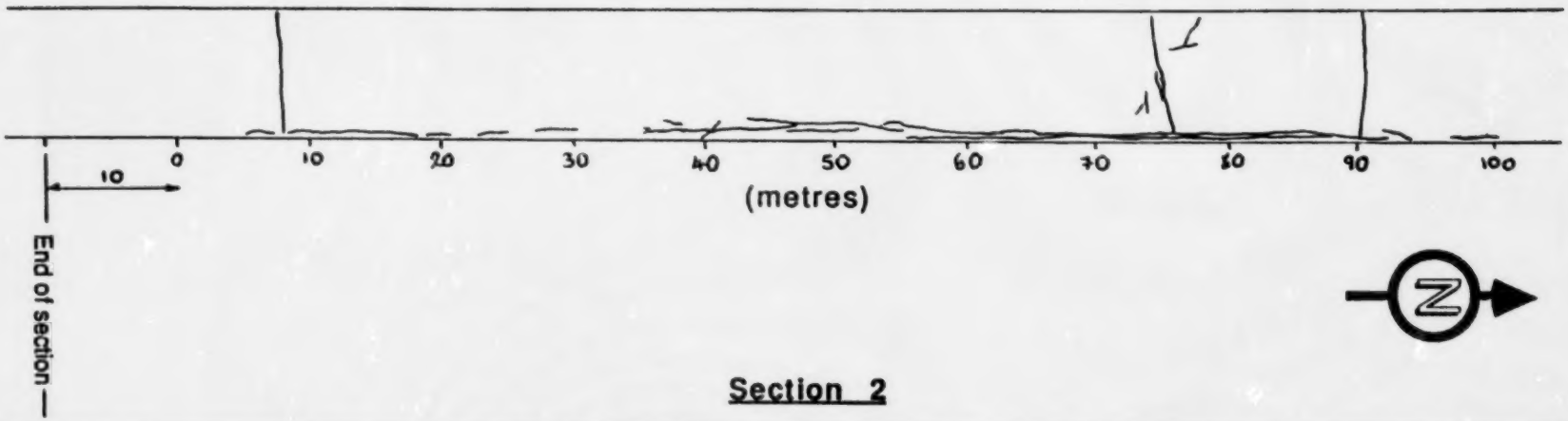


Reflux Recycling Agent, Highway 45 from Hastings to Norwood

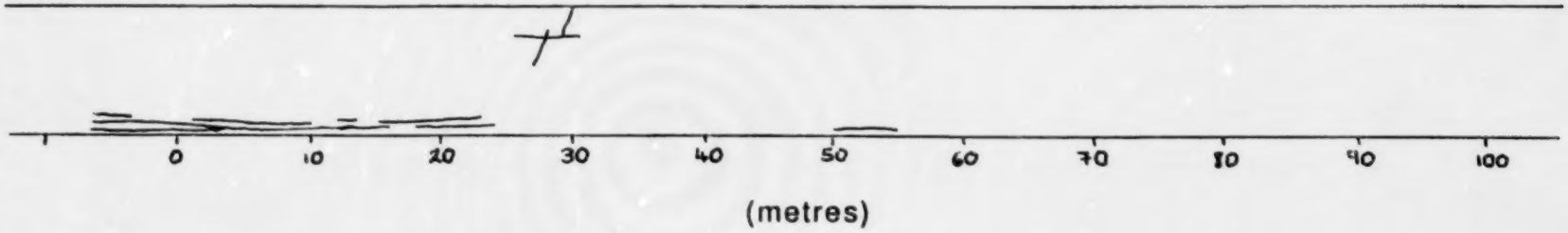
Reflux Recycling Agent, Highway 45 from Hastings to Norwood

(North bound lane only)

Section 1

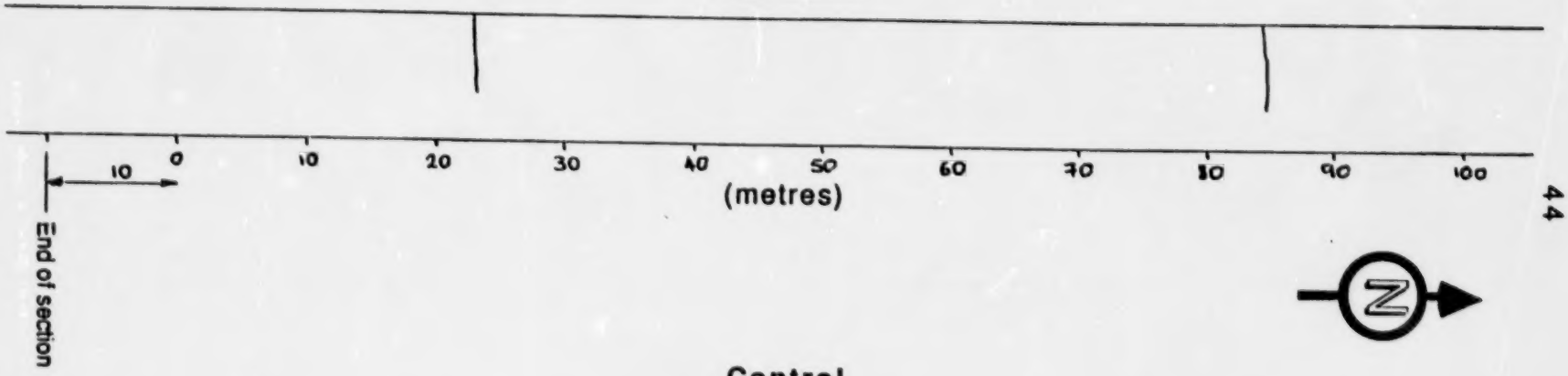


Section 2

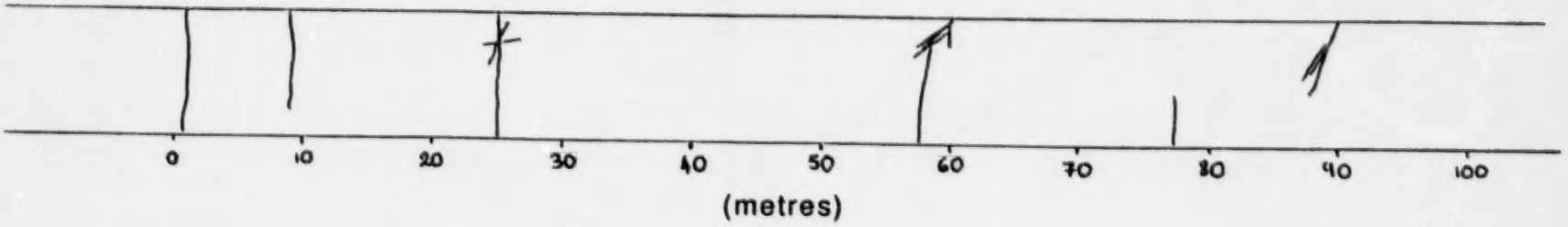


Reflux Recycling Agent, Highway 45 from Hastings to Norwood
(North bound lane only)

Section 3



Control



3.9. File number 638

Subject: Single surface treatment over hot mix using 'Styrelf' polymer modified emulsion.

Date

Author

Summary

1. Regional Road 8, south of Highway #3 in Haldimand-Norfolk District. The original pavement, placed in 1975, had good cross section with coarse aggregate pop-outs and centre-line and transverse cracking. In August 1987, RS-2P polymer emulsion from Koch Asphalt Ltd. was sprayed and 10 mm aggregate rolled in. A control section using unmodified emulsion was placed south of the test section.

2. Highway #620 east of Apsley from Bolmer Road to West Bay Road was treated with a single surface treatment using polymer modified CRS-2P (Styrelf) emulsion. A control section of unmodified CRS-2 was also laid, both sections using Class 1 Pinewood Aggregate from Lakefield. Aggregate loss was observed after 10 months service in 0.5 m x 15 m long strips in both test and control sections. This was probably caused by snow ploughs denuding heaved areas. Alligator cracking in the original pavement had been sealed by the surface treatment, but larger cracks (2-3 mm) had reflected through.

3. The City of Oshawa placed some Styrelf polymer modified single surface treatment on 12th July 1988 on Regional Road #33 (Harmony Road) between the 6th and 7th Concession Roads to the north east of the city. The original pavement surface had extensive edge cracking and alligator cracking, and had been patched in places. The shape of the road was generally good, providing an acceptable ride. The contractor had some problems with his distributor when starting to treat the north bound lane. Otherwise, the work went without problems and the initial appearance was good.

Visual Inspection

1. Regional Road #8, Haldimand-Norfolk District was inspected in March 1988 and the surface treatment found to be in good condition with no visual difference between the RS-2P and RS-2 areas.

Class 1 aggregate loss was observed at the centreline and in the centre of each lane over approximately 5 per cent of the total area. The losses were equal on the RS-2P and RS-2 areas and were probably caused by snow plows equipped with carbide blades shearing the high spots of the pavement. There was also aggregate loss along the edges of 10 mm wide cracks in four or five areas. It was not expected that the aggregate loss from the ploughs would recur in future winters.

The test section had a streaky appearance caused by uneven coverage from the emulsion distributor and this has led to a high binder level - approximately 75 per cent up the stone. Elsewhere the binder distribution is about right.

2. Highway #620 at Apsley was inspected in May 1988. Both sections exhibited extensive transverse and longitudinal cracking and aggregate loss at the centre and edge of the pavement due to plow chatter. Aggregate retention and macro texture in the wheel paths were generally good in both sections. The CRS-2P trial section had a binder level approximately 60-70 per cent of the aggregate depth. The CRS-2 control section was streaked indicating an uneven distribution of the emulsion and had 3 small (250 mm diameter) pot-holes which had been patched.

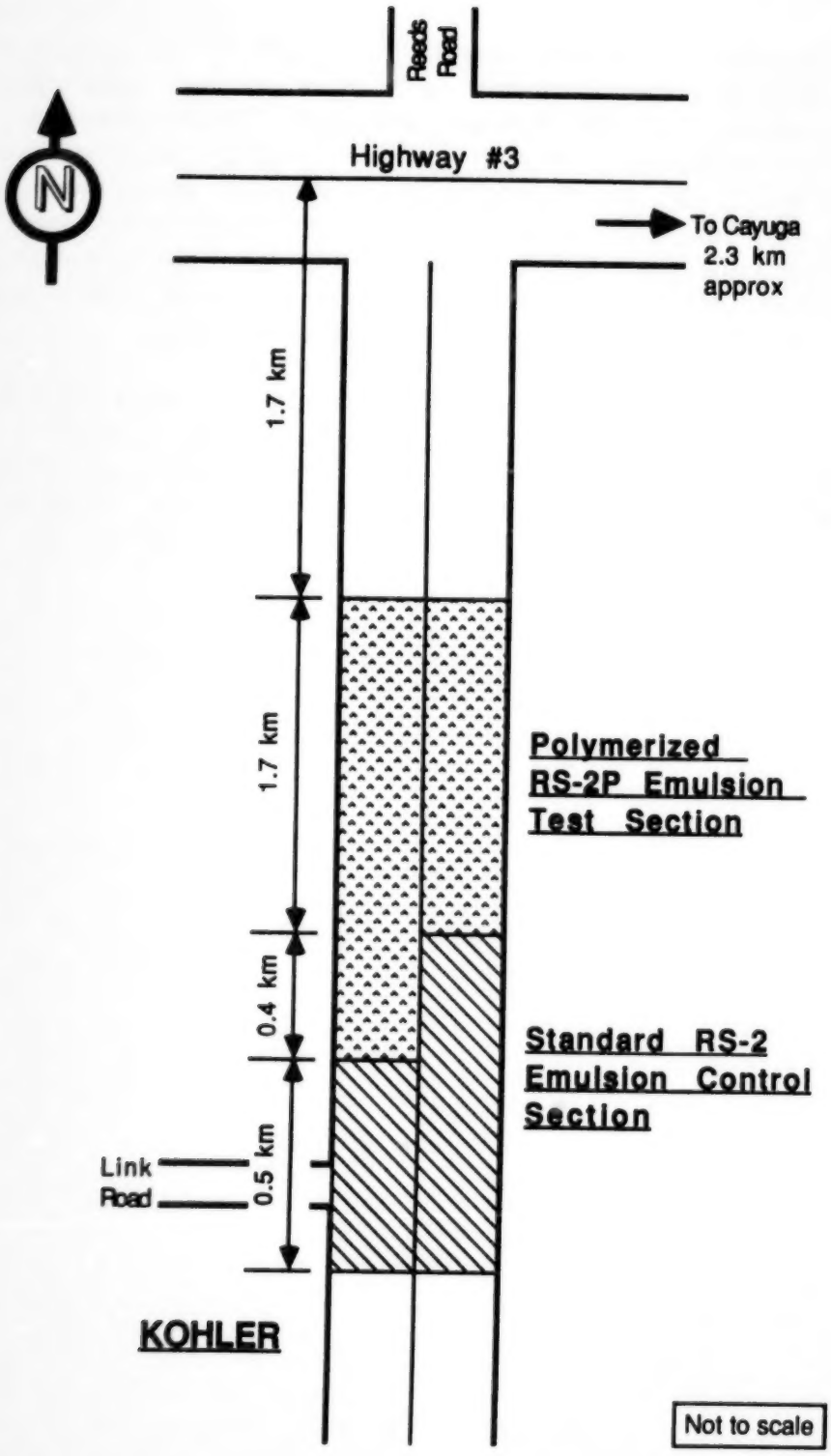
The CRS-2P trial section at the eastern end of the site appeared to be in better condition than the western, control section with less aggregate loss and less cracking. However, it is considered likely that the original pavement in the eastern trial section was in better condition than the western end, and this has significantly affected the relative performance.

Proposals for future work

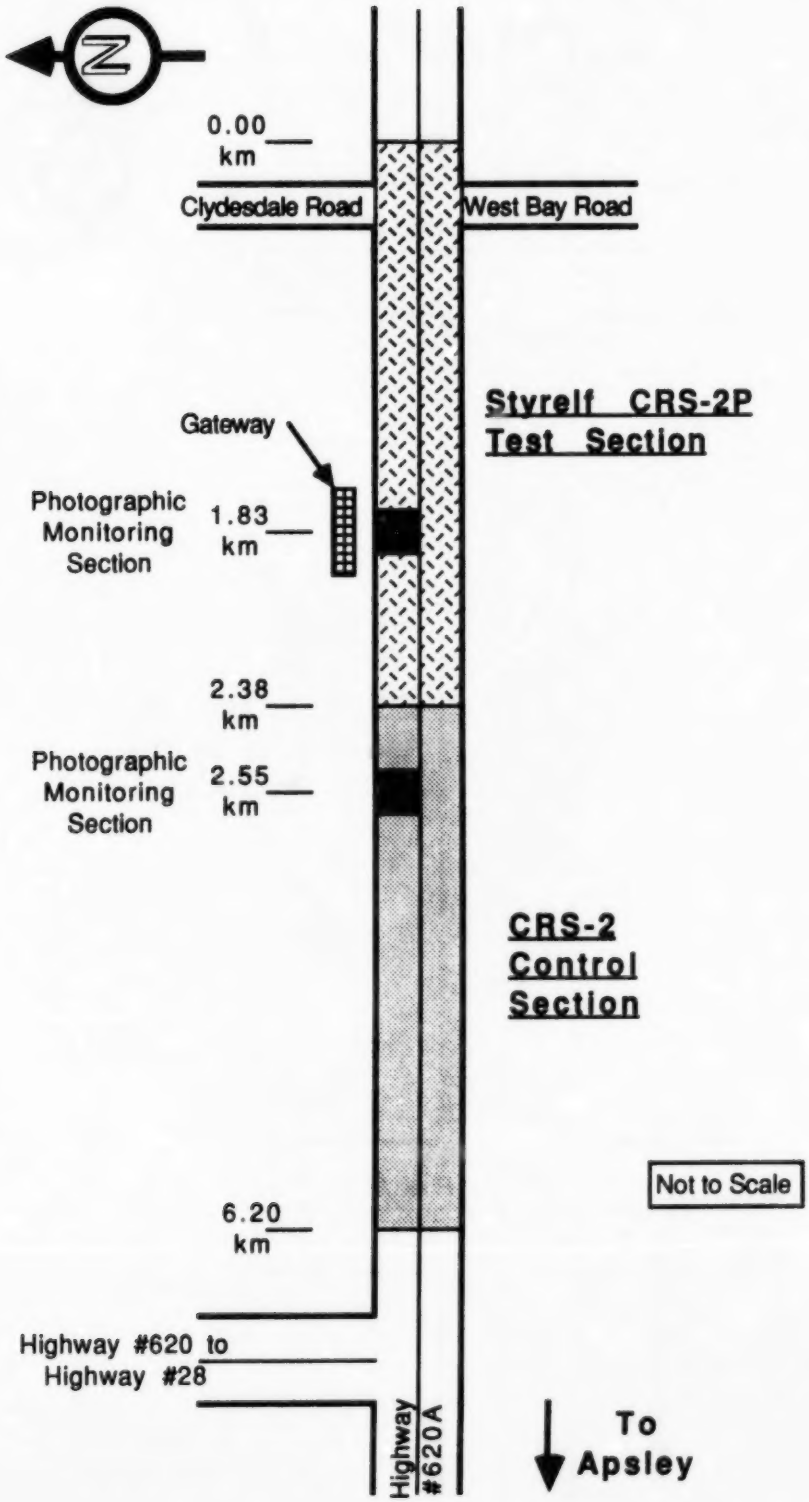
1. These trials should be considered in conjunction with those assessed in Report MI 116 which were also treated with Styrelf polymer modified emulsion. The modified emulsion is more expensive than the standard material and any extensive use of the modified product can only be justified by an improvement in the overall performance of the resulting surface treatment.

2. Surface treatments add very little strength to the pavement structure and their performance is therefore very dependent on the behaviour of the underlying materials. This makes the relative assessment of standard and modified materials very difficult and can be misleading as on Highway #620, noted above. The modified material is apparently performing better than the standard material, but it is certain that the original pavement condition was worse where the standard material was laid and this has greatly affected the relative performance.

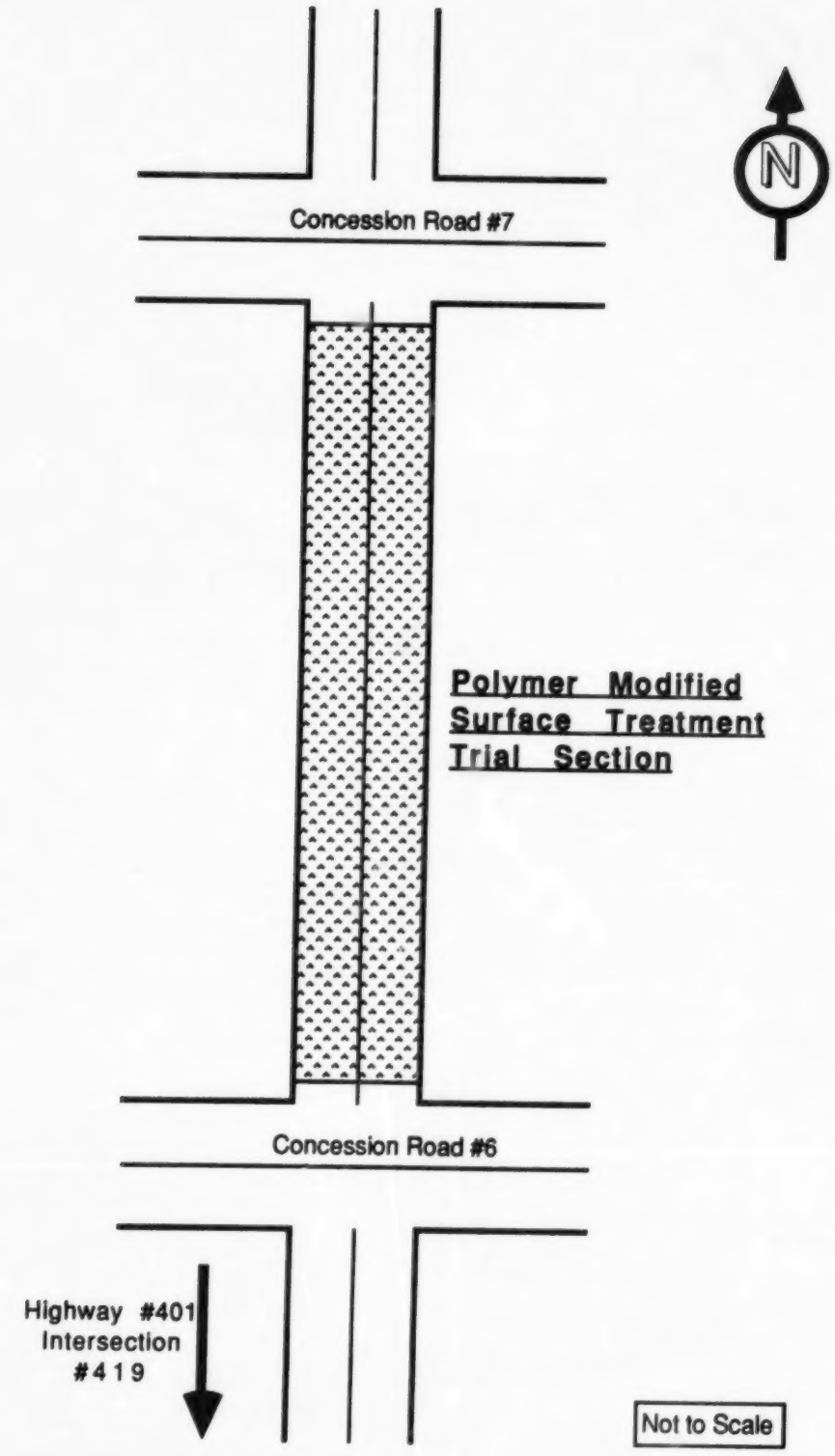
3. Until a number of experimental sites are indicating conclusively that the modified materials are superior to the standard treatments, it is suggested that the visual monitoring of the existing sites should continue and some additional sections be laid in order to increase the amount of data available.



Polymerized RS-2P SST - RR #8 Haldimand-Norfolk



Polymer Modified SST - Highway #620 near Apsley



Polymer modified SST - Harmony Road, Oshawa

3.10. File number 770

Subject Seal coat trial (or Fog Seal) on Highway #115/35.

Date

Author R C Aquin

Summary

The DFC pavement on Highway #115/35 exhibited high porosity that was thought likely to create winter maintenance difficulties. It is probable that the openness of the material allows the salt brine to run through the mixture and away from the surface where it is needed. It was decided to spray an emulsion seal coat (also known as fog seal) on to the DFC wearing course surface which was laid in 1986.

SS-1 asphalt emulsion was diluted to 40 per cent residual asphalt content but was found to be not sufficiently fluid. Further dilution to 25 per cent residual asphalt seemed to be satisfactory and this was spread at a rate of 0.50 kg/m^2. The final product was tested and found to have an actual residual asphalt content of approximately 34 per cent. Traffic was diverted from the surfacing for one to one and a half hours after the application of the fog seal.

Conclusions

1. The DFC became slippery on the following day due to high ambient temperatures, and was sanded.

2. Five months later the DFC looked flushed in the wheel paths. Asphalt cement could be scraped from between coarse aggregate particles.

3. There were no signs of asphalt stripping.

4. Permeability and friction testing were carried out before and after the sealing.

Visual Inspection

Permeability and friction measurements were made soon after the fog seal was sprayed and these results are shown graphically in Figures 1 and 2 respectively. A few permeability tests were carried out in the southbound lanes before and after the fog treatment was sprayed. The results can be summarized as follows:

Station Number	Permeability (mean of 3 results) (ml/min) Date: 19 May 87	(ml/min) Date: 21 May 87	Remarks
19+100	25	5	
19+350	230	70	Right wheel track
19+350	50	55	Centre of lane

The results indicate that there was a substantial loss in friction resistance which was sustained for a short period of time and may have been worse if the pavement had not been sanded the day following the application of the fog seal. This was accompanied by a significant reduction in the permeability of the surfacing. Permeability is known to correlate well with pavement longevity and significant reductions in this parameter are desirable. A reduction in permeability would also indicate that loss of brine through the DFC in the winter would be reduced.

It has been found, however, that a sizeable reduction in the permeability is achieved by the action of traffic but this reduction is, of course, restricted almost exclusively to the wheel paths, leaving the remainder of the pavement relatively unchanged. It would appear from the limited number of tests carried out before and after the spraying of the fog seal in the southbound lane, that this treatment also is made more effective by the action of traffic kneading the asphalt into the surfacing. The results from the tests carried out in the wheel tracks indicate a sizeable reduction in the permeability, while the testing at the centre of the lane shows an actual slight increase in the permeability after the application of the fog seal.

Inspections were made of the trial site in March and May 1988 when the fog seal was about 1 year old. The application seems to have tightened the surface making it apparently impervious. There has been some loss of macro-texture and the surfacing appears to be over-rich and shiny in places when compared with the untreated material. It is believed that this is a surface phenomenon only as the fog seal will not penetrate far into the hot mix. Therefore, although the surfacing appears to be over rich, it is considered very unlikely that it will create a flushing problem. The northern limit of the trial section is very distinct in the south bound lanes but obscure in the north bound lanes due to carry-over of excess binder by vehicle tyres. Frequent, almost continuous, damp patches were observed at the centre of the untreated pavement indicating the porous nature of the original surfacing.

Proposals for further work

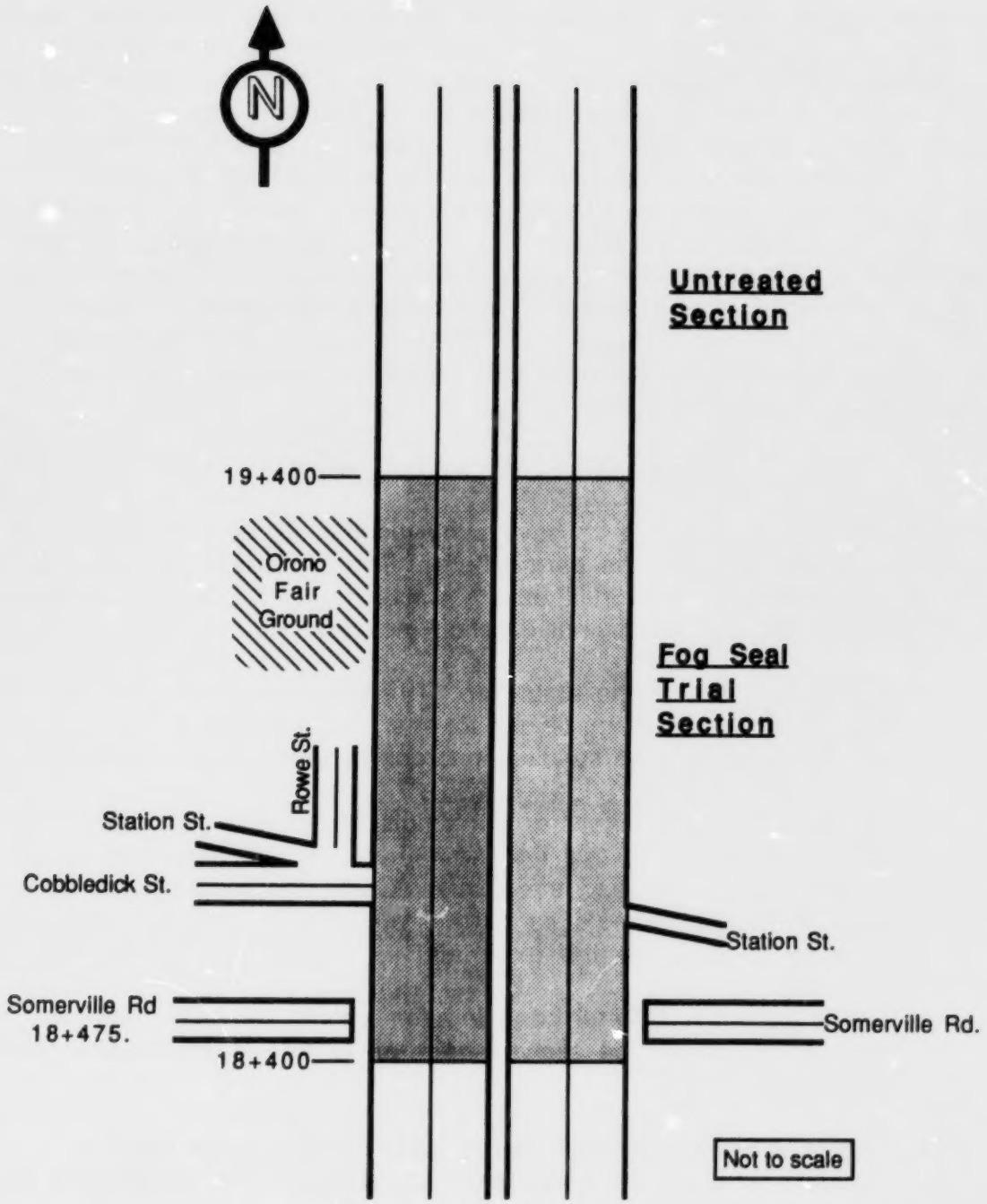
The fog seal process appears to have achieved the objective of closing up the surfacing and reducing the permeability. The procedural methods do need to be improved, however, should a similar treatment be considered in the future. Points that need consideration include:

1. Application rate of the emulsion. The rates should be adjusted so that there is sufficient binder to seal the pavement without the need for subsequent sanding in order to restore skid resistance.

2. Residual asphalt content of the emulsion. It was not appreciated when preparing this trial just how dilute the emulsion had to be in order to be sprayed effectively. Some trial applications at various dilutions should be carried out prior to any further work in order to optimize the materials.

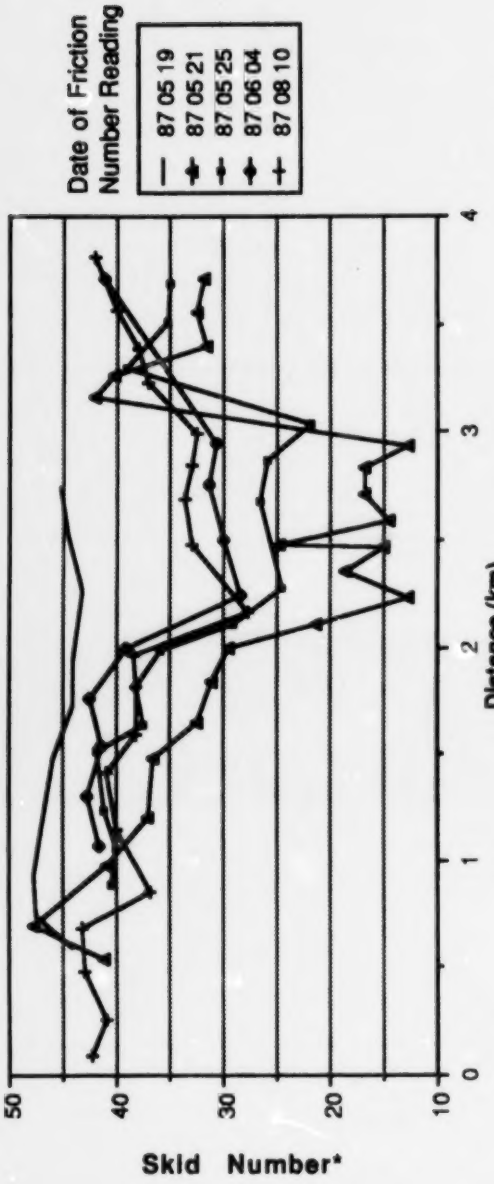
3. Traffic control. Careful consideration should be given to how soon traffic should be allowed back on to the pavement after the treatment.

4. This trial should be inspected visually on an annual basis to evaluate whether the treatment has extended the serviceable life of the pavement.



Fog Seal Trial - Highway #35/115, Orono

Below: This DFC pavement had a high friction resistance. The fog sealing was carried out on May 20, 1987. 24 h after fog sealing, the friction resistance dropped to below 15, but quickly recovered to around 25.



* Note: Friction numbers are measured at 80 km/h.

Fig. 1 Friction Resistance - Highway #35/115

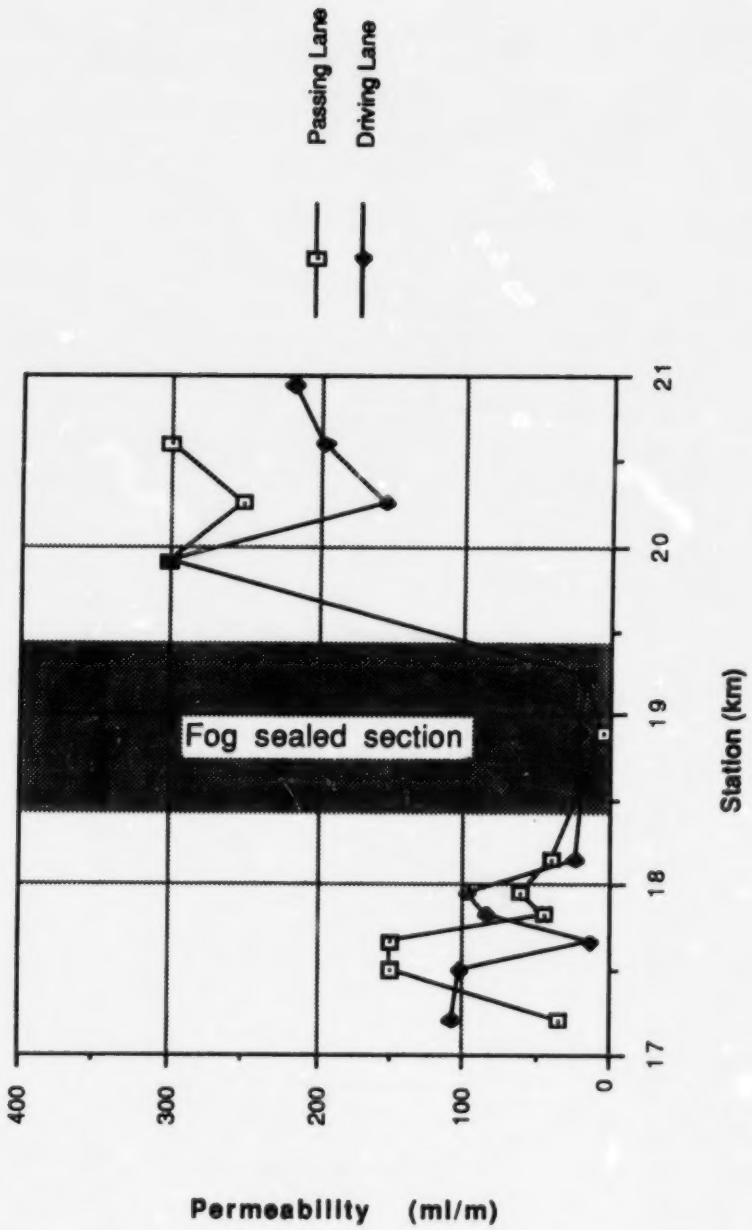


Fig. 2 Permeability tests - Highway #35/115

4. Conclusions

4.1. It is imperative that the long term assessment of test sections be considered when establishing trial sites. The selection of the site, together with the making of accurate records of its location, are essential factors in enabling the best possible information to be obtained from the experiment. The cost of these trials can be significant and it is therefore most important to make the best use possible of the investment of public funds. It is also important to ensure that new materials and methods are fully assessed in the fairest possible way. A method for establishing test sites has been suggested.

4.2. Many of the sites reviewed in this report can be abandoned by the Bituminous Section. Further assessment is required as follows:

4.2.1. Highway #7/12
The visual inspection of the Bituminous Treated Base should continue, paying particular attention to the degree of cracking in the BTB and RHM sections. Samples should be recovered to evaluate the properties of the materials in the mix.

4.2.2. Highway #11
The lime treated section of Highway 11 will be the subject of a full EMO report. The site should be inspected annually for the next few years as part of the overall assessment of the material.

4.2.3. Highway #28
The Dynapac HR21 Integral spray patcher trial section should be visually inspected for the next few years to assess the long term performance of the system.

4.2.4. Highway #35/115
The fog seal trial site should be inspected on an annual basis to see whether the treatment will extend the service life of the pavement.

4.2.5. Highway #45
Crack monitoring of the test site should continue. Samples should be recovered to evaluate the properties of the mixtures.

4.2.6. Highway #46
The Dynapac HR21 Integral spray patcher trial section should be visually inspected for the next few years to assess the long term performance of the system.

4.2.7. Highway #60
The Dynapac HR21 Integral spray patcher trial section should be visually inspected for the next few years to assess the long term performance of the system.

4.2.8. Highway #117
The Dynapac HR21 Integral spray patcher trial section should be visually inspected for the next few years to assess the long term performance of the system.

4.2.9. Highway #121
Visual monitoring of the site where 10 - 13 mm aggregate was used in the surface treatment should continue annually. Skid numbers will be measured this year. It is suggested that a reappraisal be made of the economics of using this system.

4.2.10. Highway #401
The Latex modified OFC trial section should be crack mapped and permeability testing carried out. Samples should also be recovered for laboratory analyses.

4.2.11. Highway #520
The Dynapac HR21 Integral spray patcher trial section should be visually inspected for the next few years to assess the long term performance of the system.

4.2.12. Highway #620
The stabilized base used near Chandos Lake should continue to be visually inspected and a reassessment made of the economics of using this material against imported Granular 'A'. The District should be advised that crack sealing of the Highway may be beneficial.

4.2.13. Highway #620
The polymer modified surface treatment of Highway 620 near Apsley should continue to be visually inspected, paying particular attention to aggregate loss and loss of surface texture.

4.2.14. Regional Road #8
The polymer modified surface treatment of Regional Road #8 in Haldimand-Norfok District should continue to be visually inspected, paying particular attention to aggregate loss and loss of surface texture.

4.2.15. Regional Road #33

The polymer modified surface treatment of Regional Road #33, Harmony Road in Oshawa, should continue to be visually inspected, paying particular attention to aggregate loss and loss of surface texture.